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Coal Pier with Car-Dumping Machine at Sandusky

A new pier with car-dumping machine has been built by the Pennsylvania Lines at Sandusky, O., in order to increase its coal-shipping facilities at that port. This work included the following: (1) Removing an old crib dock or pier 60x725 ft.; (2) increasing the width of slip from 140 ft. to 200 ft.; (3) constructing a new crib-and-concrete pier 1225 ft. long; (4) erecting a coal-car-dumping machine of 100 tons capacity; (5) making a fill for the new storage tracks; (6) rearranging the old storage tracks; and (7) dredging mud and rock to 22 ft. below mean lake level.

The old and new coal piers extend approximately north from the shore line and are separated by a slip 200 ft. wide, in which vessels lie to take coal. The length of water front of each pier is about 900 ft. The new work was commenced in September, 1913, and completed in July, 1914. Fig. 1 shows the new pier and the car-dumping machine, fronting on the slip between the two piers. Fig. 2 is a general plan and shows the track layout serving the two car-dumping machines.

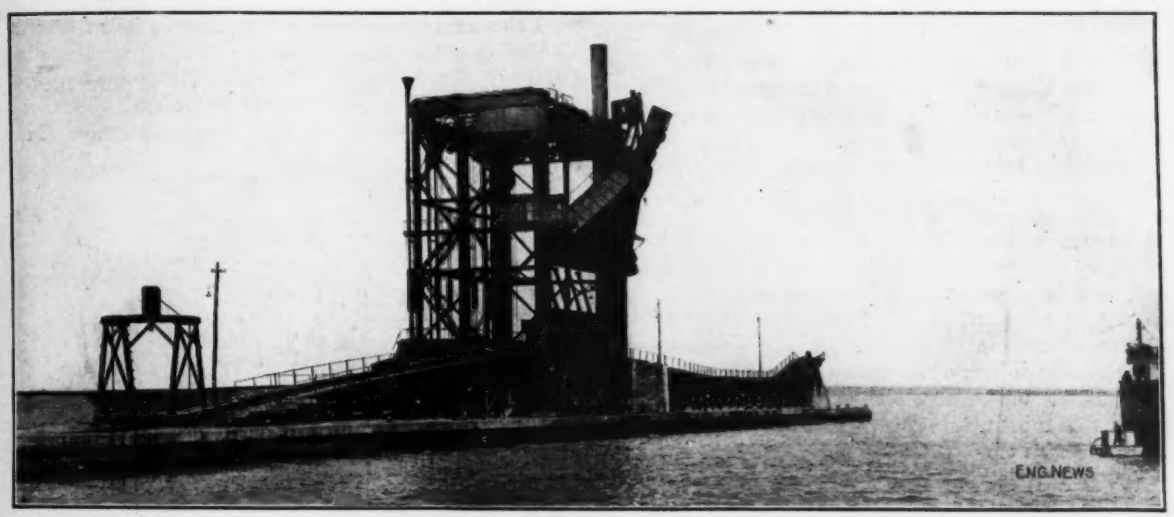


FIG. 1. COAL PIER WITH CAR-DUMPING MACHINE FOR LOADING VESSELS AT SANDUSKY, OHIO; PENNSYLVANIA LINES

(The empty cars run from the machine [toward the right] by gravity, and return to the yard on a gravity track. When the machine is in service its triangular apron or hopper is lowered and a spout dropped into the hatchway of the vessel.)

PIER AND SLIP

OLD PIER—The old pier which was removed consisted of two lines of timber cribs 16 ft. wide and 25 ft. deep, set with their faces 60 ft. apart. The space between the cribs, as well as the crib pockets, was filled with dirt and small stone, and the whole structure was tied together with 1¾-in. rods at intervals of 10 ft. This work was removed by a dipper dredge without difficulty, taking out the cribs at the rate of 75 lin.ft. per day.

For widening the slip, about 15,000 cu.yd. of rock was taken out. Holes for blasting were drilled 5 ft. c. to c. Along the line of the pier, however, holes were drilled 7 in. c. to c., but not blasted, an extra charge of dynamite being used in the last row of holes 5 ft. away. This was done to prevent blowing out the rock under the location of the new cribs and also to give a straight line of rock face from bottom of cribs to bottom of slip, this distance being several feet in some cases. About 100,000 cu.yd. of mud was taken out with a dipper dredge.

NEW CRIB-AND-CONCRETE PIER—The new coal pier consists of wooden crib substructure and concrete superstructure, as shown in Fig. 3. The cribs are made of 12x12-in. hemlock timbers and average about 18 ft. deep and 20 ft. wide. They were partly built on ways, then launched and completed in the water, with the exception of the deck course. They were then towed to position, lined up, sunk with one-man stone and anchored to steel car axles set in the rock.

The top of the cribs being 2 ft. below mean lake level, the deck was built with the forms for 2 ft. of the concrete top attached. The deck sections were floated over the cribs and sunk into position by depositing concrete in them. Pipes set in the concrete allowed drift bolts to be driven to secure the deck to the main part of cribs. The rest of the concrete superstructure was then placed, having a width of 10 ft. at the base and 6 ft. at the top. Cast-iron mooring posts are set 48 ft. apart along this pier.

For a portion of the west side of the pier, near its outer end, a line of sheetpiling is substituted for the cribs. The sheeting is of steel piles, with reinforced-concrete piles at intervals to carry the load; these latter are anchored to the rock to hold the sheeting in line.

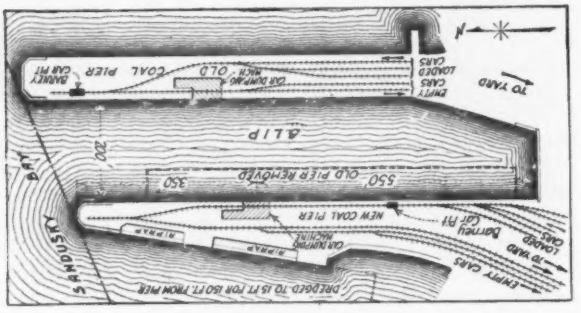


FIG. 2. PLAN OF COAL DOCKS, SHOWING TRACK LAYOUTS FOR THE TWO CAR-DUMPING MACHINES

FILLING—About 190,000 cu.yd. of filling was required to make the storage yard for loaded and empty coal cars. This was loaded with steam shovels into standard-gage dump cars and hauled about two miles to the pier. A light pile trestle was built out from shore on the line and grade of the gravity storage yard and this was first filled. Then the track was thrown over as filling progressed. The water side of the fill is protected with stone riprap, which was also handled largely with dump cars from a neighboring quarry. The new yard has capacity for about 186 loaded and 77 empty cars. The old yard as rearranged holds about 195 loaded and 84 empty cars.

CAR-DUMPING MACHINE

The machine for dumping coal cars (Fig. 1) is located about 550 ft. from the shore end of the slip. Its foundation consists of 13 reinforced-concrete piers 20 ft. high and 5½ ft. diameter, on rock foundation. They are tied together at the top by reinforced-concrete beams and a floor slab, the bottom of the beams being 6 in. above lake level and the top of floor slab being 7½ ft. above lake level. This substructure construction is shown in Fig. 4.

Steel forms were used for the piers. These were set up in their proper location with a floating derrick and held in place by means of a steel template made of 6x6x½-in. angles. The diameter of the circular angle around the piers was made slightly larger than the outside diameter of the form, to allow of some adjustment of the forms after the template was placed. The bottoms of the steel forms were held in place with cement sacks filled with a 1:1 mixture of cement and sand. The cylinders were coated with heavy oil as a protection from ice.

Previous to placing the forms, two car axles were set in the rock at each pier location, to serve as anchors for the pier. The cylinders were then filled with concrete placed by the tremie method. The end of the spout was closed and placed on the bottom, and opened when the spout was filled with wet concrete. The spout was not allowed to run empty between batches. The steel forms were left in place. Stone and dirt filling was placed around the cylinders before the forms were built for the beams and floor slab.

The car-dumping machine is of the Hulett type and is designed to handle 100-ton loads. The car is run into a cradle, which is then raised and tilted, discharging the coal into a triangular apron whose upper end is longer than the car, while its narrow lower end terminates in a chute entering the ship's hold. In this way the coal slides and flows rather than falls, thus reducing the amount of breakage. The cradle is counterweighted so that the hoisting-engine is relieved of part of the lifting load.

The approach grade is 11% and the haulage car is provided with a tail rope to the drum of the engine, which is of the reversible type. This gives control of the haulage car at all times. Steam is furnished by three 200-hp. boilers. The cradle is placed 25 ft. above mean lake level, in order to reduce the cradle-hoisting operation as much as possible, and also to more nearly equalize the time element of hoisting and overturning, with that of haulage.

OPERATION

Trains of loaded cars are pushed from the storage yard to the load tracks of the dumper yard and set on tracks so that as many of the loads as possible will be placed on the dumper side of the summit. These cars are then cut off and handled singly by gravity, and as the tracks are emptied, they are filled by pushing more loaded cars over the summit. The arrangement of grades and the methods of handling cars are different in each case, as explained below, and are shown in the profile, Fig. 5, and plan, Fig. 2.

PRESENT PIER—Here the operation is indirect. The loaded cars are pushed from the yard on an ascending grade of about 0.8% and then descend by gravity on a grade of 1.25% (or 1.9% on 10° curves), and then on a level stretch to the reversing or kick-back grade. This

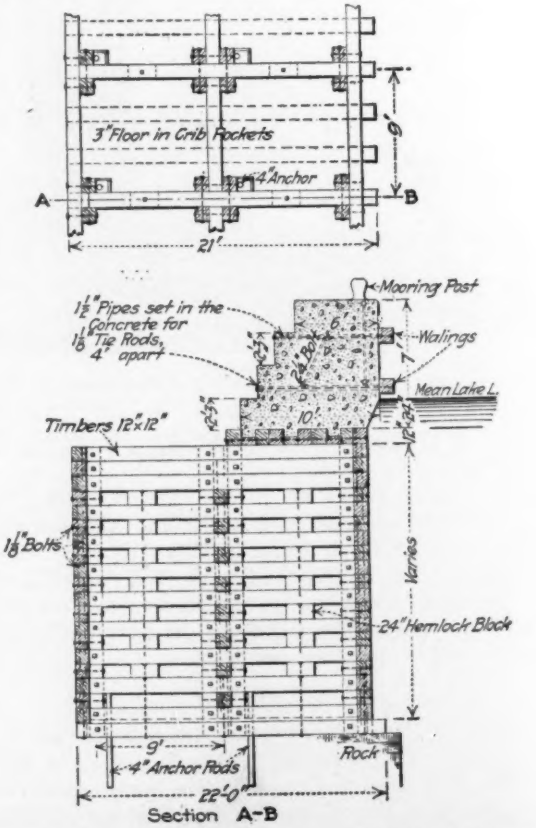


FIG. 3. CONSTRUCTION OF CRIB-AND-CONCRETE FACE OF COAL PIER

reverses the motion and the car drops back to the pit of the haulage car or "barney." The barney car pushes the coal car up a grade of 7% to the cradle of the coal

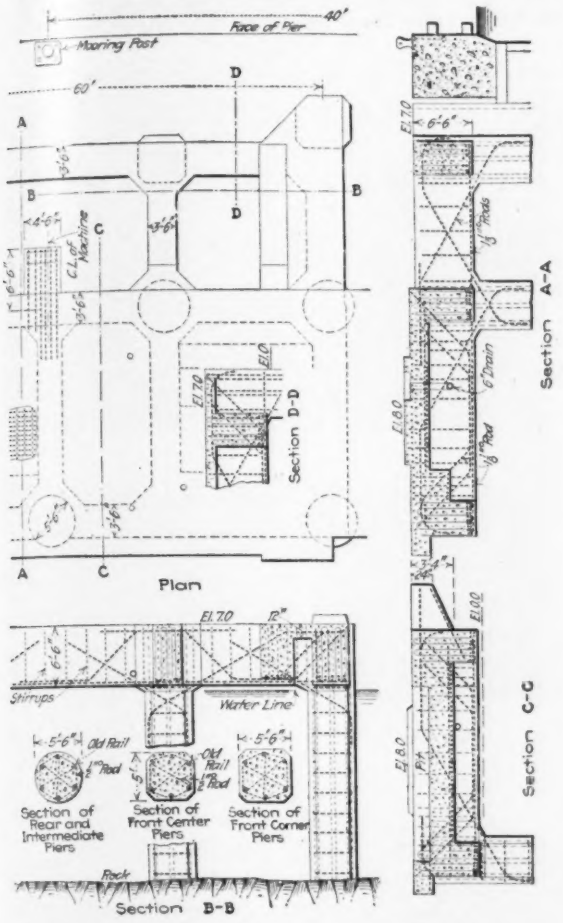


FIG. 4. CONCRETE PIERS AND DECK FORMING THE SUBSTRUCTURE FOR THE CAR-DUMPING MACHINE

dumper, and the empties then return to the yard on a gravity track of 1.5% grade, increased to 1.9% at 10° curves.

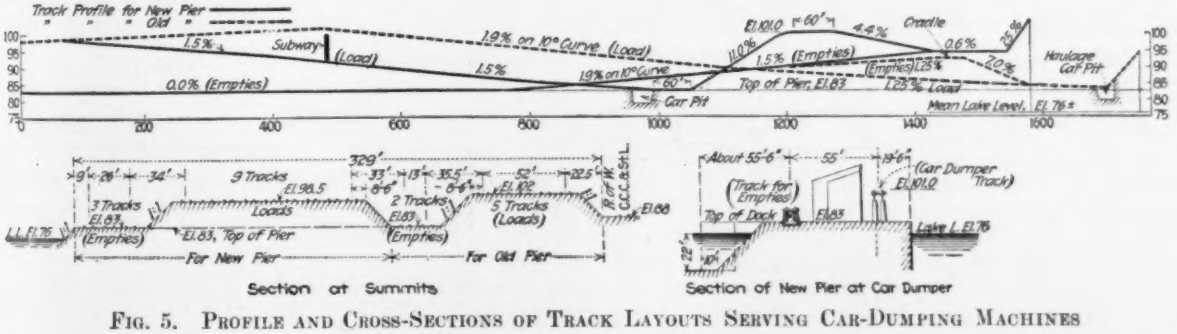


FIG. 5. PROFILE AND CROSS-SECTIONS OF TRACK LAYOUTS SERVING CAR-DUMPING MACHINES

NEW PIER—The loaded cars ascend from the yard on a grade of about 1% and then descend at 1.5% (increased to 1.9% on 10° curves), crossing the haulage-car pit and then stopping on a 60-ft. level stretch. The haulage car then pushes the coal car in the same direction up a grade of 11% to the cradle of the car-dumping machine. The empty car (still moving in the same direction) runs down an accelerating grade of 4.4% and along a short track to a reversing or kick-back grade of 25%. This reverses the motion, and the car is returned to the yard on a gravity track of 1.5%.

ENGINEERS AND CONTRACTORS

The machine was built by the Wellman-Seaver-Morgan Co. The filling was done by the H. E. Culbertson Co., and the dock work, dredging and car-dumper foundations by the Great Lakes Dredge & Dock Co. The plans and specifications were prepared under Robert Trimble, Chief Engineer of Maintenance-of-Way, Pennsylvania Lines (Northwest System), and all work was done under his direction. H. W. Peterson was Engineer in Charge.

Promotion Examination for Assistant Engineer

At a recent civil-service examination given by the city of Columbus, Ohio, for the position of Assistant Engineer at a salary of $100 per mo. to start, open only to transitmen who had been in the employ of the city for 3 mo., the following questions were asked:

Experience and Education; Weight, 3

1. Give the name and location of the schools you have attended, and the date of entering and leaving each.
2. Give in detail your experience for the past five years, with the names of your employers and the nature of your work.
3. Give the names of three former employers as references.

Duties; Weight, 2

1. What are the duties of the position you now hold?
2. What are the duties of the position for which you apply?
3. Draw an outline map of the city.
4. What would you do if one of your subordinates frequently made mistakes?
5. What would you do if one of your subordinates was indolent?
6. What would you do if one of your subordinates came on to the work intoxicated?

Mathematics; Weight, 5.

1. Define dimensions.
2. How many dimensions has a surface?
3. How many dimensions has a line?
4. How many dimensions has a point?
5. What is geometry?
6. What is a scalene triangle?
   What is an isosceles triangle?
7. Give five axioms.
8. How much is saved by going by the hypothenuse instead of around the two sides of a right triangle with the sides 92 and 69 rods?
9. One square has 12¼ times the area of another; what is the relative size of the sides of each?
10. A square farm contains 250 acres. What is the length of one side and of the diagonal?

Cutoff-Wall and Rock Grouting at the Milton Reservoir Embankment

SYNOPSIS—Earth embankment across a glacial valley has upstream cutoff wall, built behind steel sheeting. Concrete slope-paving will bond with the cutoff wall. The rock under the wall is being grouted to close any crevices. Pipes were set in the wall 5 ft. apart, and drilling and grouting through these is now going on.

A river-equalizing reservoir to improve the Mahoning River, at Youngstown, Ohio, is being built by the city at a point about 35 mi. upstream or 16 mi. due west of Youngstown, in Milton Township, Ohio. An earth embankment with concrete spillway dam, 2840 ft. total length and 40 ft. high above mean valley bottom, will impound some 10 billion gallons of water, drawing from a drainage area of 300 sq.mi. This embankment has various noteworthy features in its design, most of them being directly related to a concrete cutoff wall sunk to rock along the upstream edge of the embankment. A new phase of the construction work developed during the past fall; namely, the use of pressure grouting through pipes and drilled holes in the rock to close off seams which might allow underflow.

The dam is fully shown by the topographic plan and the cross-sections in Fig. 2. The design of the embankment itself is simple, there being no core-wall and

FIG. 1. MILTON RESERVOIR EMBANKMENT; SPREADING AND ROLLING

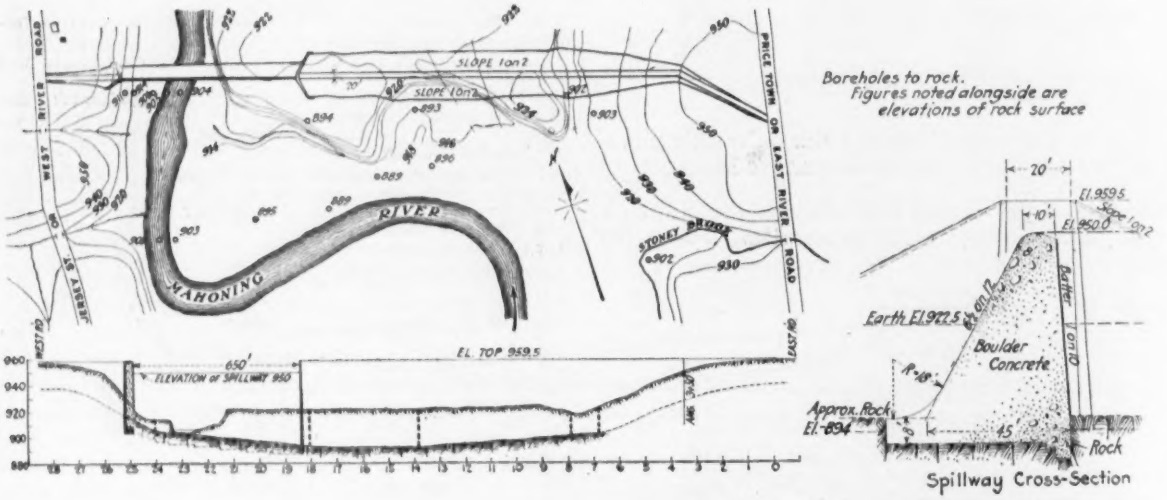
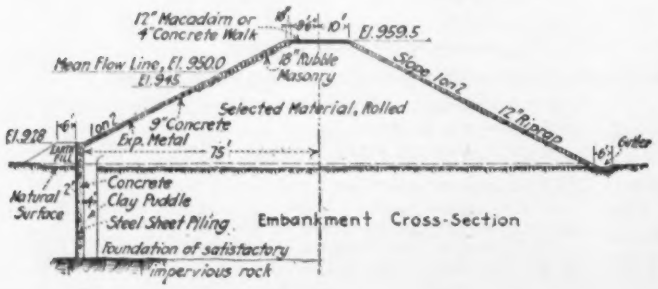


FIG. 2. MILTON RESERVOIR EMBANKMENT: PLAN AND SECTIONS



(Note—Downstream slope of spillway dam will be made 7 : 12 instead of 6½ : 12 as designed. The top of the embankment will have a 3-ft. wall along the upstream side)

reliance being placed on thorough roller-compacting (see Fig. 1) of a good tight mixture of sand and clay. An upstream slope paving of concrete (stone in the region of wave wash) is provided.

The valley-bottom soil had been well explored by drilling before the plans were developed. Rock is 25 to 30 ft. down, and the overlying material was

known to be rather variable, embracing layers of firm clay and layers of sand or gravel. The foundation rock is a fine-grained sandstone rock which in its upper part is in layers from 6 in. to 30 in. deep. This rock is known to be not less than 60 ft. thick, and furnishes an excellent foundation. Some water naturally follows the seams in the rock. At irregular intervals there are vertical seams or fissures. The valley has all the characteristics of a glacial valley cut through the strata of rock and partly filled with clay, gravel and river silt.

On the showing of the borings it was thought wise to provide a complete water-tight cutoff wall from base of embankment down to rock. In view of the provision of slope paving, the best arrangement was concluded to be an upstream cutoff wall which, at its top, would make junction with the slope paving.

The design of the embankment and in fact the entire reservoir was worked out by the city engineering department of Youngstown, Frank M. Lillie, Chief Engineer, along lines recommended by J. W. Ledoux, Consulting Engineer, who went over the entire situation previous to the preparation of plans. W. M. McCartney is Superintendent of Construction.

The cutoff wall was designed with special view to a rather novel method of construction. Upstream sheeting of interlocking steel sheetpiles was to be driven to rock before excavation started. This steel sheeting, left in place, would in effect form a complete cutoff without the concrete, but in the trench excavated behind it a 30-in. wall of concrete was to be built, and the rest of the trench-width then backfilled. A sheet of expanded metal was to be set in the top of the wall and later bent over to bond into the lower part of the slope paving.

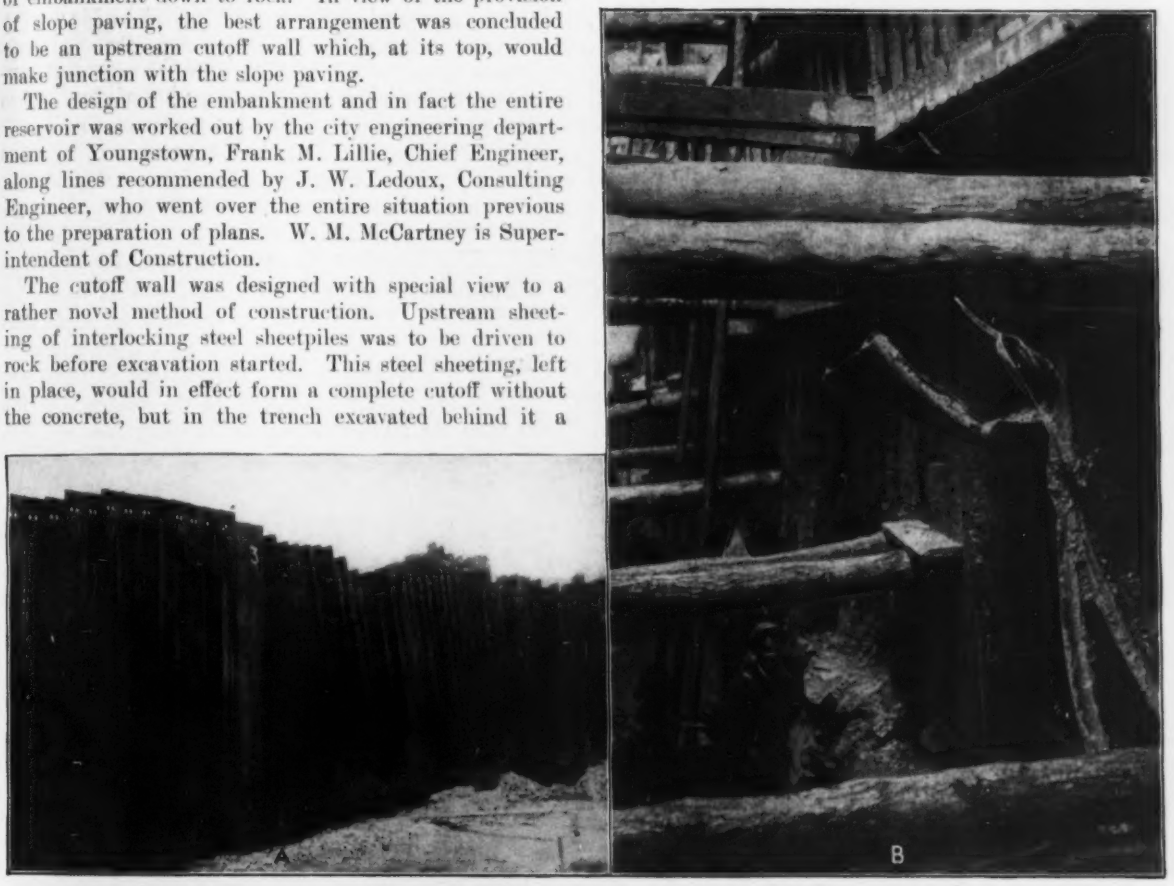


FIG. 3. STEEL SHEETING ON UPSTREAM EDGE OF CUTOFF TRENCH, MILTON RESERVOIR EMBANKMENT
(Left view shows one of the laps necessitated by crooked driving. Right view shows a failure of the interlock)

The contract on the plans as shown was let Nov. 27, 1913, to L. Adavisio, of Youngstown, on a unit-price basis. The contractor sublet the earthwork of the embankment to L. I. Fletcher, of Kent, Ohio. During the past season, the cutoff sheeting has been driven (see Fig. 3), the trench excavated and practically all of the cutoff wall concrete placed (Fig. 6). Work has also progressed at the extreme west end of the concrete spillway section in the foundation and placing of the four sluiceway pipes. Construction has begun on the spillway (concrete dam), but not much has been accomplished. The wings of the east abutment have been partly constructed and a small portion of spillway foundation placed at the west end. Half or more of the embankment has been placed and rolled (see sketch, Fig. 4).

The excavation of the cutoff trench did not meet with many difficulties, although some had been anticipated. Inflow of water between the points of the steel sheetpiles and the rock, which might have brought in much dirt, was much less than anticipated, and in fact the soil proved to be so tight as to hold water almost absolutely. The only flow of any importance came up through occasional fissures in the rock.

The fissures were drilled and grouted before depositing the bottom concrete. In order to fill any crevices that might exist the specifications called for 10-ft. drill holes every 10 ft., to be filled with grout under 40 lb. pressure. In case it was found that the holes would take no grout the drilling and grouting were to be omitted. This work, as carried out by Mr. McCartney, embraced some special features. Grouting pipes were set at intervals of 5 ft. throughout the length of the cutoff wall and two months ago work was started at drilling down through these pipes and grouting.

The stage of work at the present time, with operations practically closed down for the winter, is sketched in a very approximate manner in Fig. 4. Here the cutoff wall is shown completed practically to the level of the final junction with the concrete slope paving. The expanded-metal reinforcement is left projecting out of the top of

the cutoff wall some 5 or 6 ft., to be bent over and imbedded in the paving slab when this is placed. About the middle of the wall thickness is shown a grouting pipe (3-in., in some cases 4-in.), resting on the rock bottom of the trench and projecting about 1 ft. above the top of the concrete.

Drilling and grouting is carried on in the following manner: The contractor has secured a 2-in. shot drill supplied by a vertical steam boiler set up nearby on a separate base. With this, holes are drilled through the grouting pipes to a depth of usually about 12 ft. below rock surface, but in some cases deeper, up to a maximum of 20 ft. Alternate pipes are drilled, the intermediate ones being left untouched until later. The drilling goes on without difficulty and yields good cores, except that the main seam, which is about 5 or 6 ft. below rock surface, causes a loss of the shot and the water in the first holes drilled.

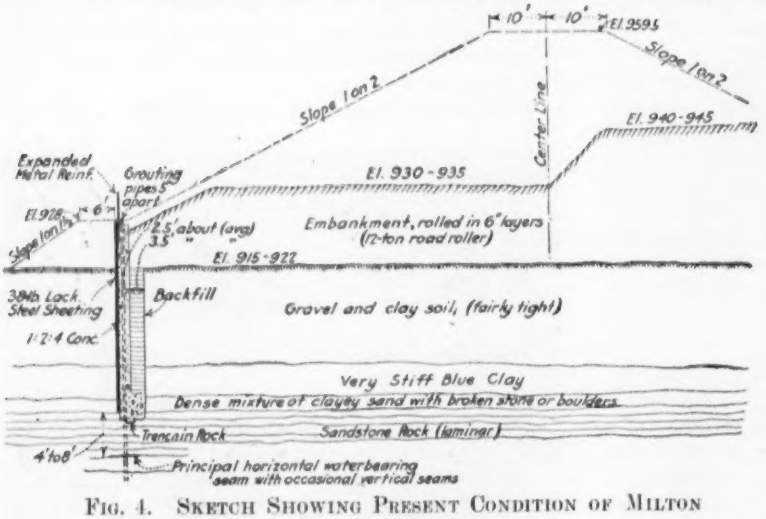


FIG. 4. SKETCH SHOWING PRESENT CONDITION OF MILTON RESERVOIR EMBANKMENT

GROUTING

The grout is mixed in an open box set over the top of the pipe, and the grout is spouted through a valve at the top of the pipe. By a connection from the water line laid along the embankment, the grout is washed down into the hole as fast as it flows in from the mixing box. As soon as the flow of water and grout shows signs of stoppage, the valve at the top of the grout pipe is closed, to let the water-line pressure act on the pipe full of grout. Then a small booster pump in the line is used to put on a pressure of over 100 lb. per sq.in. The diagram sketch (Fig. 5) gives the arrangement used in the grouting.

The grouting will probably continue through the winter, so that by spring matters will be in shape for rapid continuance of work on the embankment and possibly the starting of slope-paving work later in the season. At the same time the main work on the spillway dam will begin, preliminary to which the normal river flow will be diverted through the sluiceway pipes at the extreme west end.

The grouting so far has covered about 75 pipes, and the work has gone on to the entire satisfaction of the engineer in charge. The intermediate holes, drilled after grouting alternate holes (10 ft. apart), usually do not

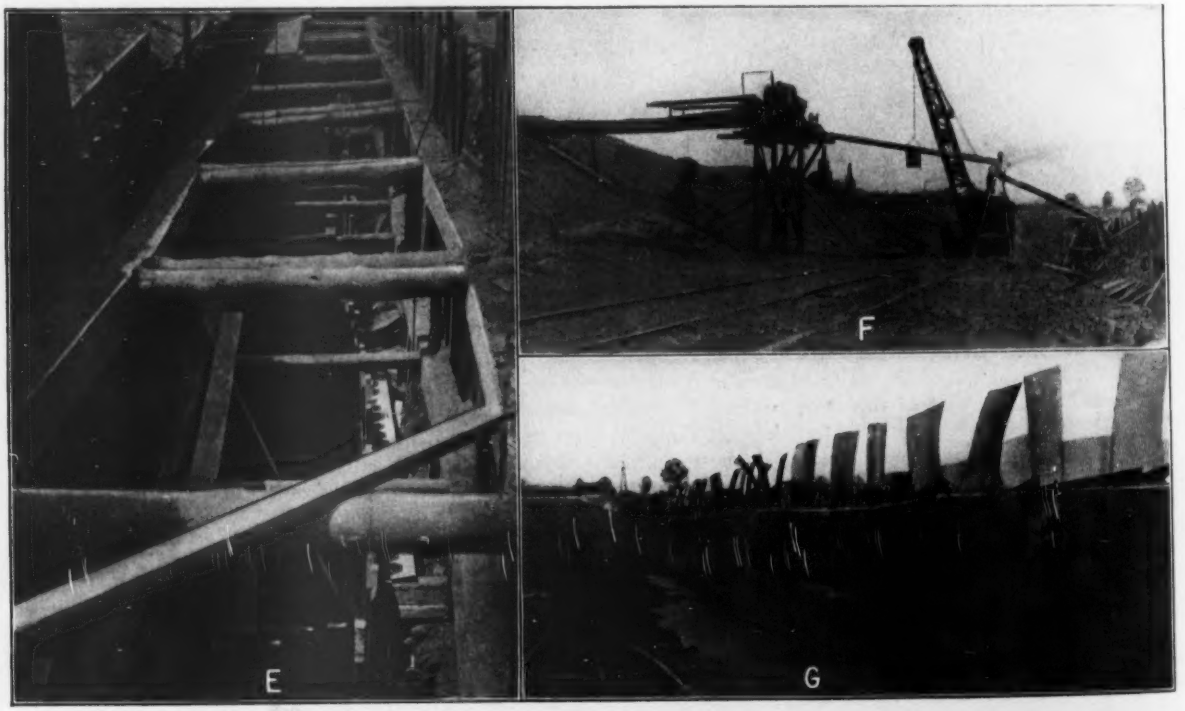


FIG. 6. CUTOFF-WALL WORK, MILTON RESERVOIR EMBANKMENT

take any grout, and give evidence that the grouting of the first set of holes was effective.

The earliest holes drilled consumed an average of about 15 sacks of cement. The amount decreased with the subsequent proving holes to an average of two or three sacks per hole.

Some History of the Stadia Method of Surveying

It is not generally known that the first use of two parallel hairs in a telescope for measuring distances—that is, the principle of the stadia—was first introduced, at least among English-speaking people, by that versatile genius, James Watt. Nor is it generally known that James Watt was a good deal of a civil engineer before he turned his attentions to the development of the steam engine.

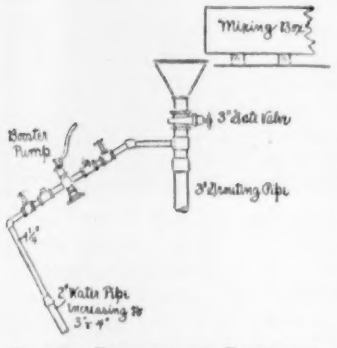


FIG. 5. SKETCH OF GROUTING ARRANGEMENT, MILTON DAM

The following sketch of the invention of the stadia is in Watt's own words. It was printed in a long-forgotten and little known periodical called the *Edinburgh Philosophical Journal*, in 1819, not long after the death of Watt. The article is not only interesting in throwing light on the history of the stadia, but gives an excellent picture of Watt, who was a constitutional fault-finder and forever scheming to improve the methods of doing his work.

ACCOUNT OF MICROMETERS FOR MEASURING DISTANCES*

By the late James Watt, Esq., LL.D., F. R. S., London and Edinburgh, Member of National Institute of France, and of the Batavian Society of Rotterdam.

One of the instruments which I propose to describe in this paper was contrived about 1770 or 1771. I know I used it in the surveys of the Crinan and Gilp and the Tarbet intended canals, and also in the survey of the canal from Inverness to Fort William, now called the Caledonian Canal. The former survey was in 1772, and the latter in 1773, and it was in 1772 that I showed it to Mr. Smeaton.

The instrument I used was a telescope, with an object-glass of 12-in. and an eye-glass of 1½-in. focus, consequently magnifying eight times. In the focus of the eye-glass there were placed two horizontal hairs and one perpendicular hair. The horizontal hairs were about 0.1 in. distant from each other, and as strictly parallel to each other, and at right angles to the perpendicular hair, as I could make them. A rod being placed upright at 20 chains distant, or any other convenient distance, on level ground, an index, consisting of a round disk of about 8 in. diameter, painted white, with a horizontal line of 1 in. wide, painted on its horizontal diameter with vermilion, was fixed upon the rod about 1 ft. from the ground, and another similar index was moved up and down on the rod until, upon looking through the telescope, the two horizontal hairs covered the red stripes on the upper and lower indexes; the telescope being turned on its axis until the perpendicular hair was parallel to the rod.

The indexes being thus covered by the horizontal hairs accurately, the upper index was fixed to the rod, and the distance between the middle of the red stripes on the two indexes was divided into 20 parts, representing so many chains, which, with the instrument I used, were upon the rod about 4½ in. each; and for distances exceeding five chains this division into equal parts was sufficiently accurate; but for shorter distances it was not strictly so.

I therefore fixed a pin at every chain, and holding up the rod at each of them, made the necessary correction; and as the focus of the object-glass is also affected by the distance, it is proper to adjust the eye-glass to it at each station. The divisions on the rod being marked with the number of chains they represent, it was only necessary to send an assistant with the rod to any place, the distance of which was wanted to be measured, and by signs to make him move the upper index up and down until the two horizontal hairs covered the red stripes on the upper and lower indexes; and the divisions on the rod then showed the distance, which I found could be ascertained to within less than $^1/_{100}$th part of the whole distance, and with a higher magnifying power, could be proportionately more accurate.

The rod I commonly used was 12 ft. long, and consequently could measure 30 chains; but by sliding another rod upon it so as to lengthen it I measured greater distances, and where still greater ones were wanted, I stretched a tape horizontally and turning the telescope on its axis, made the single hair parallel to it, fixing one index at the end of the tape and sliding the other along it, until it subtended the distance between the wires. I then measured the subtended tape with the rod and so ascertained the distance; but this expedient I rarely had recourse to, the distances I generally had to measure rarely exceeding half a mile or 40 chains.

It is plain that this instrument possesses the advantage of measuring all distances with equal accuracy, until the imperfection of vision at great distances interposes, as the scale on which they are measured expands with the distances, and in uneven ground it possesses more accuracy than the chain, and is very valuable in measuring distances from one hill to another, and across bays of the sea, where the chain cannot be used, which I experienced in the survey of the West Loch Tarbert, the northern shore of which is very much indented, and so rocky that it is scarcely possible to measure a few chains in a straight line upon it.

I showed this instrument to all my friends at the time, and, among others, to Mr. Smeaton, as I have mentioned, and used it publicly in my surveys, and it was consequently known to many people, though not published.

A Mr. Green, in 1778, applied to the Society of Arts for a premium for the same invention, which Mr. Smeaton apprised me of, and also informed the Society of my claims, in consequence of which I was desired to attend this committee, where I informed them of what I had done, and at what time. Yet the Society thought fit to award Mr. Green the premium, though his invention or use of the method was posterior to mine, I suppose because he had used an instrument of higher magnifying power, viz., 40, and consequently had been able to measure greater distances, and, as was said, with greater accuracy. I made no further reclamation, as I perceived it was not in that court I could obtain justice, though there were people then living who could have attested my use of it.

The cross-hair micrometer, as described, leaving me too much in the power of my assistants, where the distances were greater than permitted me to read off the number of chains on the rod myself, I thought of another about 1772 or 1773, which consisted of a telescope with an object-glass of a long focus, say 3 or 4 ft.; this was placed in a tube with a slit in one side of it, nearly as long as the focus of the telescope, and the object-glass being fitted in a short tube, which slid from end to end of the slip, could be moved backwards and forwards by means of a piece of metal fixed to the short tube, and coming out through the slit; a glass of 6 to 9 in. focus was also fixed in the outer tube of the nature of what is called a field-glass, and to this was added an eye-piece, with a cross-hair piece at its focus.

Now it is evident that if the object-glass be moved nearer the field-glass, their common focus will be shortened, and the image at the cross-hairs diminished proportionately, until the glasses come into contact, when their common focus will be shorter than that of the field-glass alone; and two indexes fixed upon a rod being subtended by the cross-hairs at any given distance, the same rod with its indexes being moved nearer the observer, upon sliding the object-glass nearer the eye, they may be again subtended by the cross-hairs, and a scale on the side of the tube will show the comparative distance they have been removed, and the distance of the first object being known, that of the second will also be so. This scale could not, however, be a scale of equal parts, but one which could easily be laid down.

I made a rough sketch of this instrument at the time, but have never completed it, having been since engaged in concerns where such instruments were unnecessary.

*Also printed in James Patrick Muirhead's "Origin and Progress of the Mechanical Inventions of James Watt" (London, 1845), from which it was reprinted by J. L. Van Ornum in his "Topographical Survey Methods," Bulletin 10, Vol. 1, Engineering Series, University of Wisconsin.

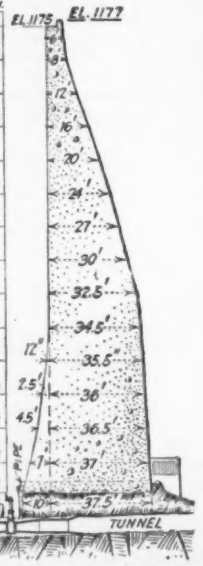
The Salmon Creek Dam; a Constant-Angle Arch Type

The principles of the constant-angle arch dam were described at length in ENGINEERING NEWS, July 25, 1912, p. 155. In this type of structure the length of the upstream radius is decreased from the crest toward the foundation in the same proportion as the cañon width decreases. With the ordinary arch dam in a narrow-floored cañon the curvature is so small near the base that the load is carried by shear and cantilever action almost exclusively. With the constant-angle dam, arch-action is theoretically utilized to the utmost near the bottom where the pressure is greatest.

The type is essentially adapted to V-shaped cañons narrow at the bottom. The principle was first applied in the Spaulding Dam, on the South Fork of the Yuba River, Calif. In this structure, however, the radius was decreased near the base only as an additional safety factor. The first true constant-angle arch dam ever built was completed near Juneau, Alaska in 1914, for hydro-electric development, by the Alaska-Gastineau Mining Co.

Salmon Creek Cañon, which is spanned by the structure, is well adapted to this type of arch, as it is narrow at the bottom and the cañon walls are steep, forming a "V" of unusual regularity. The watershed above is the result of glacial action, and is 7½ sq.mi. in extent. The altitude ranges from 4900 ft. at the highest peak to 1000 ft. at the dam site. Its confines are precipitous naked rock cliffs, while the floor of the valley is covered with an alluvial deposit of sand and gravel of considerable depth. A portion of the catchment area is heavily timbered, while the upper reaches are generally covered with snow. There is an average annual rain and snow precipitation of 100 in. over the watershed, of which a large percentage is available runoff. Measurements of the flow of Salmon Creek from July 1, 1911, to June 30, 1912, showed an average runoff of 55 sec.-ft. The seasonal rainfall at the dam site during this period of stream-gagings was below normal.

HEIGHT OF DAM ABV. RIVER BED	CONTOUR	UP STREAM RADIUS	ARCH STRESS LB SQ.IN.
168'	1175	331'	0
156'	1163	333'	217
144'	1151	325'	282
132'	1139	316'	309
120'	1127	305'	318
108'	1115	294'	320
96'	1103	282'	326
84'	1091	270'	328
72'	1079	257.5'	330
60'	1067	243.5'	330
48'	1055	228.5'	322
36'	1043	207'	309
24'	1031	187.5'	285
12'	1019	168'	258
0	1007	147.5'	242



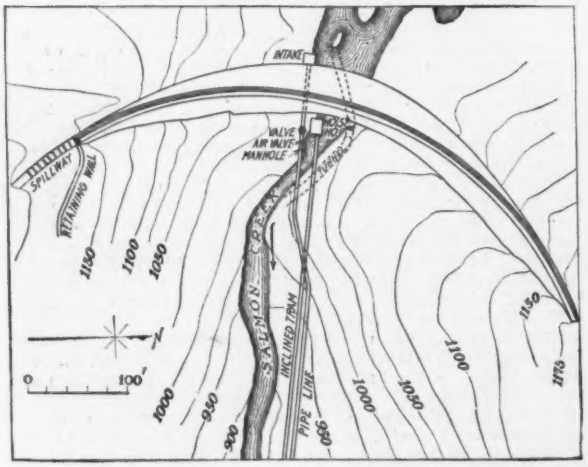


FIG. 1. DETAILS OF SALMON CREEK DAM, GASTINEAU MINING CO., JUNEAU, ALASKA

It was calculated that for years of normal rainfall a storage of 17,210 acre-feet could be relied on by the construction of a dam 60 ft. in height. With this quantity of water impounded and an efficiency of 70%, 6000 hp. can be developed.

The dam as constructed is shown in Fig. 1. From foundation to crest the height is 168 ft. The thickness at the top is 6 ft. and at the base 37.5 ft. The main intake is located at the center of the base and admits the water to a 4-ft. pipe imbedded in the concrete structure. The capacity of the reservoir varies from 449 acre-ft. at 25-ft. depth to 17,210 acre-ft. at 160-ft. depth.

A remarkable feature of the dam site is the bedrock formation in the bottom of the cañon. A level section 75 ft. in width lay exposed directly beneath the dam. This rock dips on a steep incline both upstream and downstream from the dam, so that if a gravity section wider than 75 ft. at the base had been used, excessive excavation would have been necessary. This factor was considered in adopting the constant-angle arch dam.

With the water in the reservoir level with the bottom of the spillway, an ice pressure of 10 tons per running foot was provided for. This was considered ample, as the slope of the reservoir sides at the high levels near the dam is not sufficient to confine the ice under heavier pressure. It was shown that even with an ice pressure of 20 tons per running foot the resulting compression on the concrete would be provided for with a safety factor of five.

CONSTRUCTION

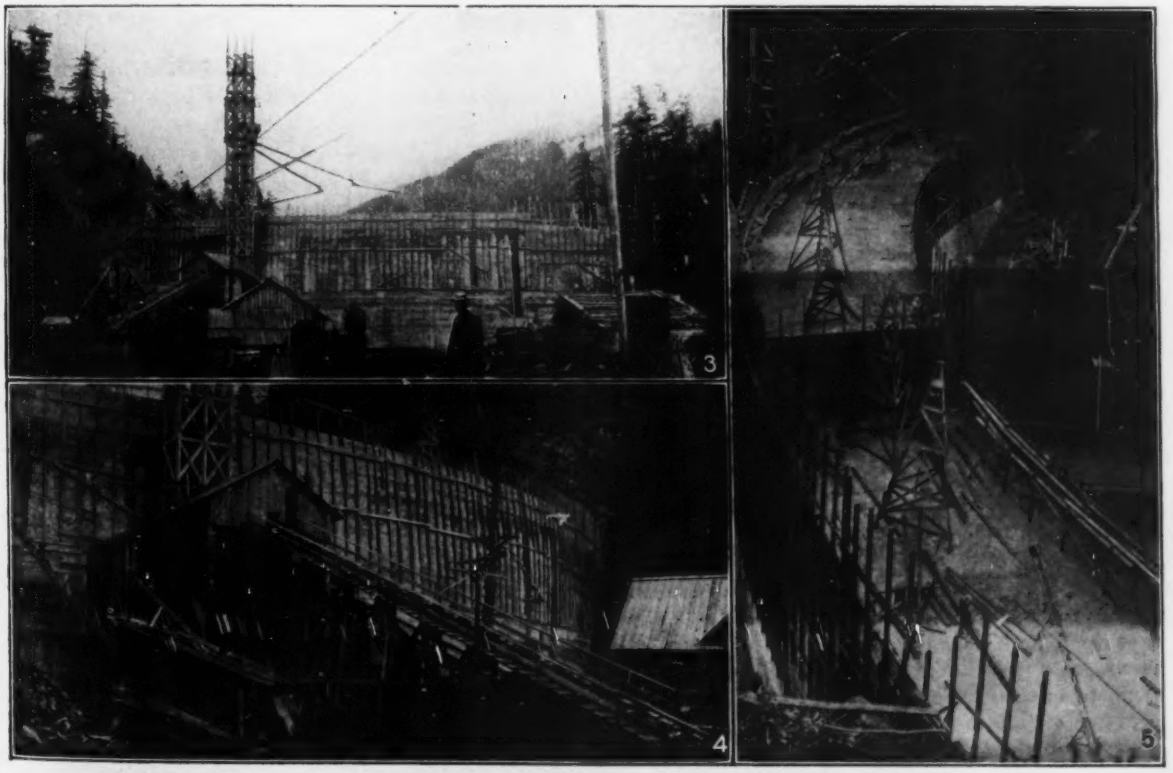
A tunnel 6 ft. in diameter was first run beneath the dam site. An extensive construction plant was erected on the upstream side. Rock was obtained from a quarry about 1000 ft. east of the dam and conveyed by tram to a crusher. Gravel was excavated by a dragline bucket from a pit to the north of the quarry and emptied into a field hopper, whence it was conveyed by a 24-in. belt conveyor to a 3-in. screen. Oversize material fell from this screen to a chute leading to a 36-in. crusher where it was broken and thence again conveyed by a 16-in. belt to the 24-in. belt leading to the screens. Below the 3-in. screen a ½-in. mesh separated the finer particles which fell to an automatic settling tank and thence to the sand bins. Cement was carried from the warehouse on an 18-in. belt conveyor to the mixing plant, which consisted of two ¾-cu.yd. batch mixers. Concrete from the mixers was raised in a double tower, from the two hoppers of which it was distributed through chutes to all portions of the dam. About 400 cu.yd. was placed daily. A total of 52,000 cu.yd. of concrete, having 5 cu.ft. of cement and a small percentage of lime, was placed in the structure by this method. Half of the dam was completed in 1913 and the remainder in 1914.

FIG. 2. UPSTREAM VIEW OF SALMON CREEK DAM, DURING CONSTRUCTION

Timber for construction operations was obtained from the forests of hemlock and spruce which immediately adjoin the dam site.

Water is conveyed from the reservoir to a power house on Salmon Creek, at an elevation of 435 ft., a mile below the dam. After passing through the turbines the tail water, together with the flow of the creek at this point, will be conveyed by a flume 10,000 ft. in length and a pipe 1650 ft. in length to a second power house on Gastineau Channel.

The Salmon Creek Dam was designed by Lars R. Jorgensen, who holds the patent for this particular type of arch. H. L. Wollenberg is Chief Engineer for the Alaska-Gastineau Mining Co. and had charge of construction, as



FIGS. 3-5. NEAR VIEWS, DURING CONSTRUCTION, OF SALMON CREEK DAM NEAR JUNEAU, ALASKA

well as the preliminary hydraulic investigations. F. G. Baum and F. C. Herrman acted in a consulting capacity.

A Permanent Track Maintenance Force on the Long Island R.R.

The employment of a permanent force for track-maintenance work is an exceptional feature of the maintenance-of-way department on the Long Island R.R.

In the early part of 1913, when there was a great demand for labor, contractors and others whose work was pressing in the summer were paying $2 per 8-hr. day. The railway was paying only $1.50 per 10-hr. day, and consequently got labor mainly of inferior quality. Many of the men obtained proved incompetent, and such good men as were obtained would not stay.

To meet this condition, the railway established a permanent track force system in May, 1913. The sections average 5½ miles of main track and 4¼ miles of sidings, with an average force of five men (including subforemen). The sections are divided into five classes, the first class covering important terminals and yards and being allowed eight men. In each successive class the number is reduced by one man, the fifth class having only four men. Under this plan the force averages 15% less than under the old system. Rates were increased to 17½c. per hour for laborers and 18c. for subforeman (allowed on about 70% of the sections), while a material increase was made in the wages of the foremen.

Before putting the plan into effect, the section foremen were fully instructed as to what was expected of them. They were to weed out gradually the inferior men and replace them with good men, giving preference to married men and those experienced in track work. The foremen were instructed to make each man understand that he would be given permanent employment if his work was satisfactory, and in case of dismissal by the foreman he would have the right to appeal to the supervisor. The foremen were made to understand that they would be held strictly accountable for the quality of their men, and must show no favoritism, this latter being a marked tendency among the Italians, who constitute the majority of the force. Further, it was impressed upon each foreman that he was being given great advantages and that the railway would demand the best results from him.

This road has an extremely heavy traffic during June, July and August, averaging about 150,000 passengers daily. The greater part of the line has cinder ballast, with some fine gravel and sand, and only a small amount of stone. For the comfort of the passengers in hot, dry weather, the ballast is coated annually with heavy oil.

As early as practicable in the spring, the force on each section completes the main-track tie-renewal work left over from the previous year, and then levels up any rough spots. This work must be completed by June 10, at which time the main-track roadbed is oiled. After the oiling the roadbed must not be disturbed except in emergency cases, and in such cases it must be promptly oiled by the section gangs, which are provided with oil and hand sprinklers for this purpose.

Throughout the three summer months, while traffic is heavy, work on the main track is practically suspended. During this period all necessary repairs are made on side tracks (including tie renewals), the right-of-way is mowed for the first time (the state law making it compulsory to mow this twice a year, between June 20 and July 10, and during the latter part of August), the necessary frog, switch and guard-rail renewals are made, and switch timbers installed. The period from Sept. 1 to about Oct. 15 is devoted to the improvement of the line and surface of main track, cleaning ditches, trimming ballast and preparing for the annual inspection, which takes place about the middle of October.

Immediately after the track inspection, the renewal of ties in main track is taken up and prosecuted vigorously until stopped by unfavorable weather. The renewal of ties in the fall is a necessity to avoid heavy work in the spring. Experience has proved that where there is a sufficient quantity of clean ballast and the subsoil is of a nature that does not readily retain moisture, this work can be done safely in the fall, if care is taken to see that the ties are properly put in and securely tamped.

As soon as the ground freezes up, and throughout the winter, the time of the section gang is devoted to cleaning culvert and drain openings, repairing right-of-way fences, renewal of frogs, switches and guard rails, and such minor parts of switches as may be necessary; repairs and renewals of crossing plank and track signs; track gaging, placing tie-plates, and distributing ties for spring renewals, practically in the order named. In addition to this, there are the usual snow and ice troubles, together with many incidental jobs that can be taken care of during the winter.

It is aimed to have the work advanced so far when the weather moderates that spring work will not be delayed beyond the allotted time, always keeping in mind the limited force. Bolts are tightened, out of face, at the same time the track is surfaced in the spring and fall. Practically all relaying and new track construction is done by extra gangs.

As a result of this system, with the assurance of permanent employment at fair wages, the force has now 95% of the men who were employed at the time of the reorganization. At the inspection last fall the track was found to be in far better condition than ever before. The conclusion is that the retention of men in service for long periods results in the acquirement of such experience and skill as to promote efficiency, and that there is a consequent reduction in expense. Such men may be classed as skilled labor rather than common labor.

At each track inspection the railway company gives first and second prizes to the division supervisors, and also to the section foremen on each division. This is well repaid by the quality and quantity of the work done, and the friendly rivalry throughout the entire force, from the laborers upward.

The men are mainly Italians, as noted above, some of whom cannot read or write while others can read and write Italian only. As these men form the source from which future foremen must be drawn, the railway company has established a free correspondence course in English and simple arithmetic, furnishing pamphlets printed in both languages. After some proficiency has been obtained, the lessons cover track-work, the "safety first" subject, and suggestions as to good citizenship, naturalization, etc. For the most illiterate, it is proposed to organize a class that can be assembled for personal instruction one or two nights a week, until the men are competent to take up the regular course. This educational system has been taken up eagerly by the men, and induces

them to stay with the railway rather than go where no such advantages are offered.

We are indebted to Coleman King, Supervisor, Long Island R.R., Jamaica, N. Y., for the information from which the above article has been prepared.

Lubricating Rails on Curves to Reduce Wear

The lubrication of the flanges of locomotive driving-wheels for the purpose of reducing the wear and cutting of flanges on sharp curves has been practiced on numerous railways with good results. Little attention seems to have been paid, however, to the possibility of reducing the wear on the rails as well as the driving-wheel flanges by such lubrication; and the results of such lubrication on rail wear are not so easy to determine. If only one engine on a division is equipped with flange oilers, the effect upon the flange wear will be evident in increased mileage between shoppings. But the effect upon rail wear would not be noticeable unless most of the engines on the division were equipped with the flange oilers.

In a paper on "Flange Oilers," read by F. W. Edwards before the Western Railway Club,* at Chicago, last fall, it was stated that at a large coach yard the engine working one end of the yard was equipped with a flange oiler, while the engine working the other end of the yard was not so equipped. An inspection of the tracks showed that in the former case the inner sides of the rail heads and the switch points and crossovers were polished smooth and showed no signs of cutting even on the sharpest leads. In the latter case, the inner sides of the rail were badly worn, switch points ground to a ragged edge, and cross-overs badly cut, while the rail cutting was made evident by the amount of fine steel flakes upon the ballast.

A thick asphaltic oil is recommended for flange oiling, as it will stick to the wheel flange or the side of the rail head and not spread over the wheel-tread or top of rail so as to cause slipping. Switch engines, working over very sharp curves, are said to have had their mileage between the turnings increased 125 to 400% by the application of flange oiling (with a reduction in rail wear also), and when the engines were sent to the shops to have the tires turned this was more for normal tread wear than for flange wear.

In a discussion of this paper, by E. E. R. Tratman (of the editorial staff of ENGINEERING NEWS) it was noted that a water jet has been used successfully for the same purpose, and was tried on the Pennsylvania R.R. as long ago as 1871. On the Duluth, Missabe & Northern Ry. the water-jet has given satisfactory results with 90-ton engines of the 2:8:0 class handling trains of 2000 tons, and also with 60-ton switching engines working over sharp curves and crossovers at the ore docks.†

An inquiry as to the effect of flange lubrication on rail wear on certain roads has brought some interesting answers. On the Coast Lines of the Atchison, Topeka & Santa Fé Ry. the use of flange oilers on the engines has proved a very profitable investment in reducing both rail wear and flange wear.

PENNSYLVANIA LINES—The question has been studied and extended experiments were made in 1911, and showed that a saving in rail wear and renewals could be effected. On a 10° curve in a period of 14 months, the nonlubricated rails were renewed twice while the lubricated rails were only slightly worn. On a curve of 3½°, however, no appreciable difference in the wear was found. The general conclusion was that on comparatively light curves it was doubtful whether the saving would be sufficient to warrant the expense of additional equipment on the locomotives.

SOUTHERN PACIFIC RY.—Flange oilers are in general use on engines having runs which include heavy curvature, but are not used to any extent in yards. The general experience has been that the lubrication increases the life of rails on curves by about 250% for the outer rail and 50 to 100% for the inner rail.

GRAND TRUNK RY.—On the St. Clair tunnel line, the use of flange oilers on the electric locomotives has reduced the wear at curves and switches about 60%. These engines were very severe on switches, owing to the great proportion of the weight carried below the frames and acting as a dead blow when the wheels struck the rails. Formerly the renewals of point rails on the curve (or turnout) side of a switch were three times as numerous as those for the straight side, but since the application of the oilers, the renewals on the curve side are very little more than those on the straight side.

EL PASO & SOUTHWESTERN RY.—On the Dawson branch, having 8° and 10° curves, flange oilers have reduced the wear of wheel flanges but have not reduced the wear of rails to any extent, owing to the greater number of unlubricated car-wheel flanges. On the Alamogordo branch, with a 5% grade and numerous 30° curves, the engineman who runs the single train equipped his engine 10 or 12 years ago with a device which delivers a small stream of water onto each rail in front of the truck, so that the rails and all wheels are lubricated. It is considered that the water is practically as efficient as the oil, and that water lubrication throughout the length of the train gives better results in flange wear and rail wear than oil applied only to the engine wheels.

Most of the 60-lb. rails on the 30° curves have been in service 10 or 12 years, but are not yet worn so badly as to require renewal. But when the line was put in operation, about 14 years ago, the rails on these curves wore so fast that it seemed probable they would have to be renewed in about three years. The lubrication, therefore, seems to have increased their life from three years to 12 (or more) years.

On the Dawson line, where oil lubrication of driver flanges has been used for five or six years, the 85-lb. rails of openhearth steel on the 8° and 10° curves are being renewed on account of wear. This line has about four trains each way daily, with 2:8:0 engines having 90 tons on the drivers, and with coal cars of 50 tons capacity often overloaded about 10%. The heavier westbound tonnage averages 4000 tons per day.

MANHATTAN ELEVATED RY.—On this line in New York City there are several very sharp curves of 90 to 120 ft. radius, over which an extremely heavy traffic has now been operated for 37 years. The rails on these curves have always been kept thoroughly greased by the trackmen; and this is doubtless one reason why the rail wear on these curves has been kept within practicable limits.

*Proceedings of the Western Railway Club, September, 1914; Secretary, J. W. Taylor, 900 S. Michigan Ave., Chicago.

†"Engineering News," June 14, 1906.

Port Development at Seattle

By Paul P. Whitham*

SYNOPSIS—Details of a comprehensive scheme for port development, with description of structures.

As a result of the Panama Canal all the important Pacific ports from San Diego to Puget Sound have become active in an effort to provide themselves with such modern facilities as would enable them to successfully compete for the anticipated increased traffic. In line with this general movement, the people of Seattle and vicinity, under the laws of the state providing therefor, organized a port district, "The Port of Seattle." Bond issues amounting to $6,300,000 have been authorized during the past two years for use in the construction of wharves, sheds, warehouses, grain elevators and other facilities required in the proper equipment of a port. Just preceding this authorization the U. S. Government in conjunction with the local authorities provided funds for the Lake Washington Canal† and the Duwamish Waterway Projects. These improvements are destined to have a far-reaching influence on the future of the port and to a degree have shaped the lines of development determined upon by the Port Commission.

Puget Sound with all its ramifications is in reality one great harbor with some two thousand miles of shore line. Seattle is located on the easterly side of the Sound, approximately 90 miles of shore line being included in the Port District. The city is situated on a hilly strip of land from two to six miles in width, lying between the Sound on the west and Lake Washington on the east.

Extending southerly from Elliott Bay is the Duwamish River, now being canalized for a distance of about five miles.

When the connection between Lake Washington and Lake Union is completed this year, the Port District will then embrace an outer salt water harbor of about 90 miles and an inner fresh water non-tidal harbor with approximately 100 miles of shore line.

Lake Washington Canal

Nature nearly provided a connection between Puget Sound and Lakes Union and Washington, but the finishing touches in the way of a lock and a comparatively small amount of excavation were left for man. This project, which is now well under way, will be practically completed during 1915.

The lock is being constructed at the narrow entrance to Salmon Bay, an inlet of naturally shallow waters. Upon the completion of the lock the water level in the Bay will be raised to the level of Lake Union, or from 8 to 9 ft. above high tide. This will create of Salmon Bay a non-tidal basin approximating in area the combined Royal Victoria and Albert docks of London. The next basin, Lake Union, located in the very heart of the city, has about 8½ lineal miles of waterfront.

Fig. 1. Looking West over Seattle Harbor, Showing the Lower

A short piece of canal work will connect Lakes Union and Washington, the level of the latter to be lowered about 8 ft. to the level of Lake Union.

Thus by passing through a single lift vessels will be admitted to a non-tidal harbor of uniform level, having a shore line of approximately one hundred miles. While the locks will admit of the largest vessels that ply the Pacific, it is likely the greatest traffic development will be along the lines of what may be termed water cartage similar to that carried on in and about Greater New York.

The completion of the canal will thus give Seattle a magnificient inner as well as an outer harbor. It will make available large areas of waterfront property suitable for industrial and certain phases of commercial purposes.

*Consulting Engineer, Seattle, Wash.; former Chief Engineer, Seattle Port Commission.

†"Engineering News," Jan. 6, 1910, p. 1.

Duwamish Waterway Project

This improvement, which is being executed under the direction of a special commission, contemplates the canalization of the Duwamish River from the south end of Elliott Bay to a point up the Duwamish Valley some five miles. On each side paralleling the waterway, marginal streets of sufficient width to allow for common use railway tracks are being laid out. Thus will be opened for industrial use a large level area provided with both water and rail shipping facilities.

Railway Terminal Situation

The lines of railway development are largely fixed by the topographic conditions.

The railway approaches from the south and east are through the Duwamish Valley and connections. Hence important railway yards and terminals are located on the flats at the south end of Elliott Bay. Farther out are located classification yards. From the north and east the railways approach the city along the shores of Puget Sound and via Lakes Washington and Union. These lines come together in the gap between Salmon and Elliott Bay known as the Interbay district, where important railroad terminals have been developed. Thus we note that the Interbay district, known as the North Terminal District, and the Duwamish, or South Terminal District, both have developed naturally as a result of topographic advantages.

Between the two districts there is only a narrow strip under the bluffs along the shores of Elliott Bay, barely sufficient for Railroad Ave., the marginal way on which are located the tracks connecting the two terminal districts. This narrow strip some three miles in length, is situated directly in front of the business center of the city and while not well suited to heavy shipping and terminal work, is naturally advantageous as a location for facilities catering to ferry, local and coastwise business. It is generally known as the "Central Waterfront District." The backbone of the port system is the marginal way (see Fig. 5) encircling the shores of Elliott Bay with extensions into the Interbay district to the north and connections with the new marginal ways paralleling Duwamish Waterway to the south. The railway lines on these marginal streets for the most part have common privileges in the franchises. With some additions and perfections now contemplated a complete coördination of the entire waterfront will be obtained. The securing for Seattle of this backbone to its port facilities is of immense value and in the future will place the Port of Seattle at a great advantage over ports that have failed to thus equip themselves. The credit for the platting of this marginal way system is largely due to former City Engineer R. H. Thompson, who had the foresight to see the need before it became generally apparent. The terminal plans were extended and perfected in 1911 by Virgil G. Bogue, of New York, whose plan of Seattle is being followed in the fundamentals.

Later, important improvements will need to be made on the shores of Lakes Union and Washington, but the principal improvements are and will continue to be made under the three great divisions suggested, as follows: I. North Terminal District; II. South Terminal District; III. Central Waterfront District.

City and the Various Port Works now under Construction

To take care of the Northwest's four primary products —namely: (1) forest products, (2) grain, (3) fruit, (4) fish and fish products—the following facilities are being provided at an approximate cost of $6,000,000: (1) Smith's Cove pier; (2) combination bulk and sack terminal grain elevator; (3) fruit cold-storage building; (4) fish cold-storage and concrete warehouses for canned and pickled fish.

I. North Terminal District

Two units are being developed in the North Terminal: (a) the Smith's Cove Improvement fronting on Elliott Bay and (b) the Salmon Bay Improvement fronting on Salmon Bay. These two improvements are about two miles apart and between them are extensive railway yards with plenty of room for expansion. The tracks are located in the Interbay draw, so that all streets are easily and naturally carried overhead, doing away with grade crossings.

The port's properties are strategically located at the waterfront ends of the railway trackage.

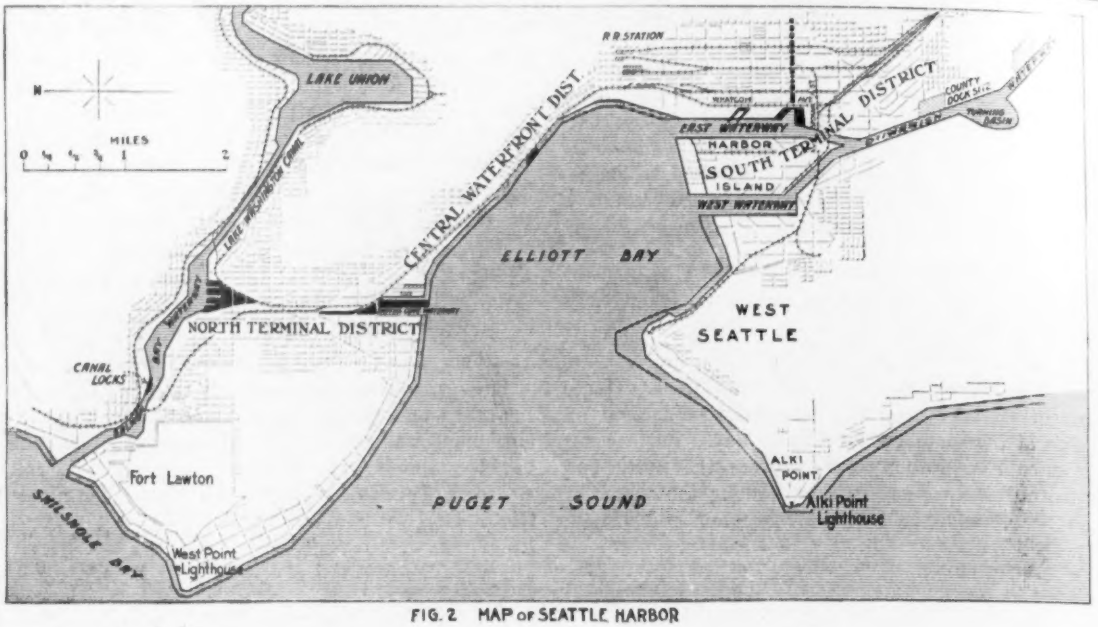


FIG. 2 MAP OF SEATTLE HARBOR

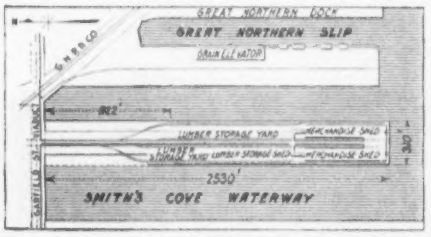
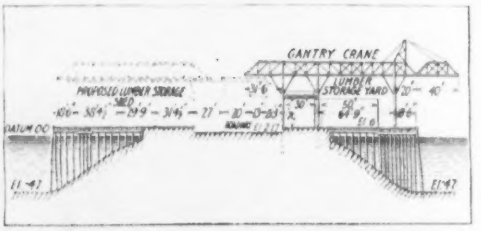


FIG. 3 - SMITH'S COVE PROJECT



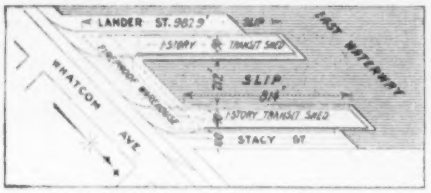
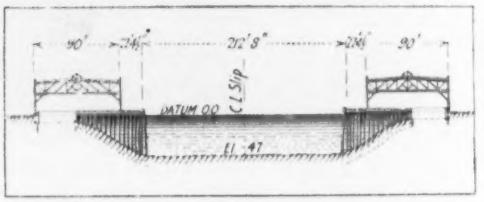


FIG. 4 PLAN AND CROSS SECTION OF STACY ST. IMPROVEMENT EAST WATERWAY PROJECT



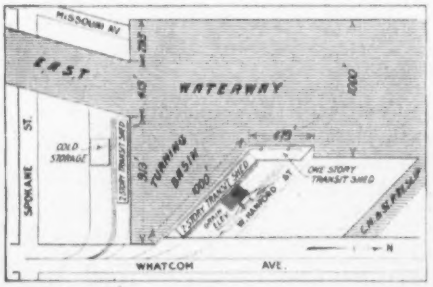
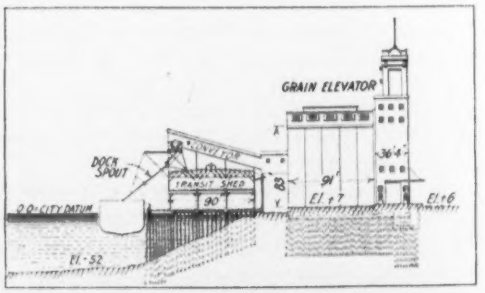


FIG. 7 THE TURNING BASIN IMPROVEMENT EAST WATERWAY PROJECT



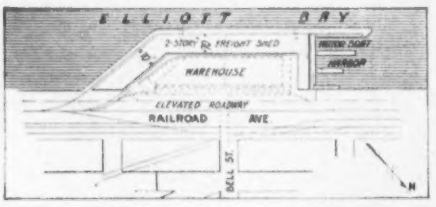
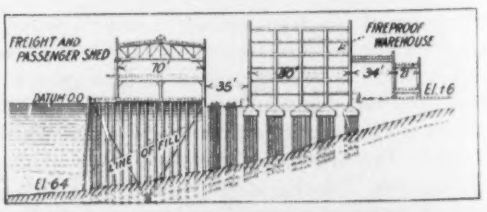


FIG. 8 CENTRAL WATERFRONT PROJECT



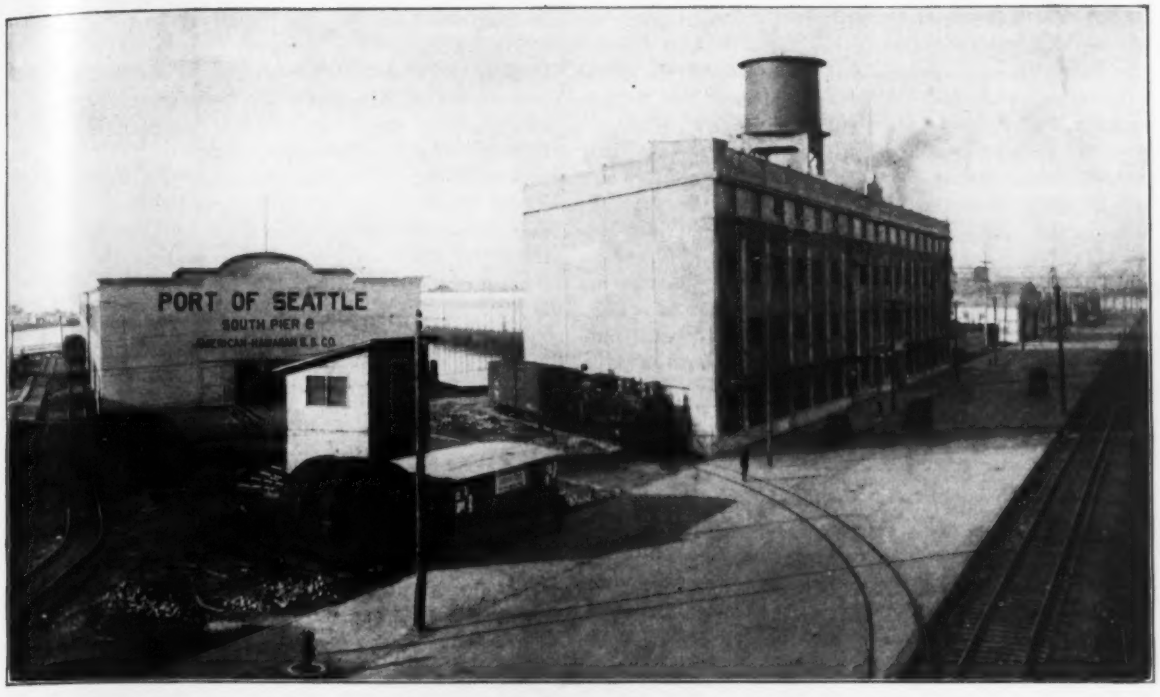


FIG. 5. THE MARGINAL STREET FRONT OF THE STACY ST. IMPROVEMENT, SEATTLE

The Smith's Cove Improvement (Fig. 3) consists of a great double-width pier 310 ft. wide by approximately 1700 ft. in length and planned to be ultimately extended to a length of 2530 ft. The central portion of the pier is filled; on the sides creosoted pile wharves are built over rock riprap slopes. Depressed tracks and a driveway are located through the center of the pier. At the outer end of each side there is a 600 ft. merchandise shed. The pier is designed, however, primarily for the handling of heavy commodities, such as lumber, rails, structural material, machinery, etc. For that reason, the major portion is an open wharf. A big gantry crane, a 15-ton locomotive and a 100-ton shearleg will be part of the equipment provided.

The size of the portion now completed can be appreciated by knowing that there are over three miles of railway tracks on the pier. North of the pier, the Port Commission has arranged for the acquisition of approximately ten acres of property for trackage and warehouse purposes.

The Salmon Bay property, some 40 acres in area, is situated in the key position in regard to the Lake Washington Canal, for the reason that it is located on Salmon Bay, the first basin inside the lock. It is also the only location on the basin where a system of large piers and slips may be constructed. Not until after the completion of the lock will the property be available for the larger needs for which it is destined to be ultimately used.

At the present time, the shore end of the property is being bulkheaded and filled and other improvements have been made, or will soon be completed that will fully equip a portion of the property as a haven for the large fishing fleet operating out of Seattle.

II. SOUTH TERMINAL DISTRICT

The South Terminal District is located at the south end of the Elliott Bay, where extensive tide flat areas have been reclaimed by using the excavated material from the East and West Waterways. These two waterways, which are 1000 ft. wide and approximately a mile in length, are the prominent feature of the terminal. Between the two waterways is a practically undeveloped district, some 300 acres in area, known as Harbor Island. With its frontage on the waterways and the opportunity of constructing at the northerly end a group of five great piers similar to the Smith's Cove pier, previously described, Harbor Island should become the most important terminal unit in the south district. It is particularly well situated in relation to the growing industrial and railway terminal district along the Duwamish Waterway and Valley. At the present time, the important tide-land development is confined largely to the east side

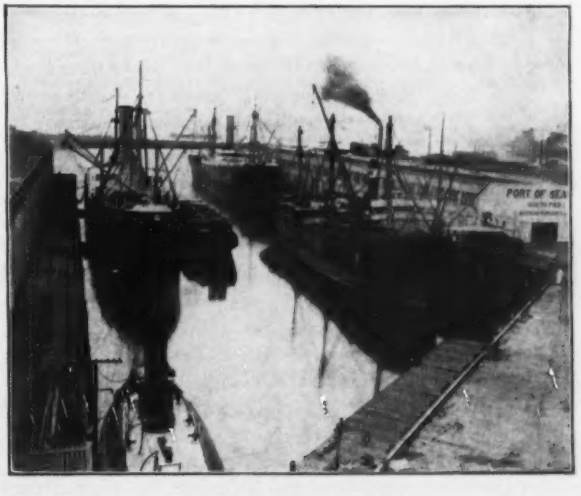


FIG. 6. TYPE OF SHIPPING NOW COMING TO SEATTLE; THE STACY ST. IMPROVEMENT

of the East Waterway adjacent to the principal wholesale and manufacturing section of the city. On that account the Port Commission deemed it wise to locate its initial improvements on that side of the waterway and to that end acquired most of the unimproved property.

There are two principal units, as follows: (a) Stacy Street Improvement; (b) Turning Basin Improvement.

The Stacy Street unit was the first to be put into service, the sheds being assigned to the American-Hawaiian Steamship Co. The improvement (Fig. 4) is a U-shaped slip 212 ft. wide by 814 ft. long. Across the inner end a 4-story concrete warehouse is planned (Figs. 5-6; the central section 80x320 ft. has just been completed. The sheds are one story, of a slow-burning type of construction covered with galvanized iron siding and tar and gravel roofing. They, as well as the other sheds be lengthened to 1000 ft. Work is about to be started on a 7-story concrete cold-storage warehouse located just back of the wharf. This building is designed as a fruit storage more particularly to facilitate the exportation of apples, but also available for the importation and distribution of citrus and other fruits.

West of the fruit-storage building fronting on the waterway a 400 ft. open wharf is being built. It is planned as a temporary landing place for fresh halibut. Between the wharf and the fruit storage a temporary cold storage for fish of 2,000,000 lb. capacity will be erected.

III. Central Waterfront District

Most of the private and railroad owned docks are located in the central district. These are for the most part reasonably well equipped to take care of the local package

Fig. 9. Looking Southwest over the Bell St. Dock in the Central Waterfront Project

erected by the Port Commission, are equipped throughout with an automatic sprinkling system.

The Turning Basin Improvement units (Fig. 7) are grouped about the Turning Basin at the south end of the East Waterway. On the northerly side, 1500 lin.ft. of wharf has been completed and a two-story shed has been erected. Back of this wharf a 500,000 bu. combination sack and bulk terminal grain elevator is being constructed. It is designed so that additional bins may be added increasing the capacity to 1,000,000 bu. Shipping galleries along the wharf front will enable the grain to be spouted to several ships at a time. The sacked grain will be conveyed to vessels through the second story of the shed. The elevator is so planned that if the need develop a marine receiving leg may be installed. There is sufficient area back of the wharf to permit the erection of such concrete warehouses as may be required in the future.

On the southerly side of the Turning Basin a contract has been let for 600 ft. of wharf on which will be erected 500 ft. of two-story shed. Eventually, this wharf will

freight and passenger business. Some of the piers have passenger accommodations equal to the best in the country. The natural life of these docks will extend over a period of several years, consequently the Port Commission decided to start its initial unit in the Central Waterfront district on a practically unimproved piece of property at the foot of Bell St. (Figs. 8-9).

The improvement is unusual and unique in many ways and can be understood only as the conditions and purposes are known. The waterfront in that location was cut off from direct communication with the retail section of the city by a 50 to 60 ft. shear bluff along the shore side of Railroad Ave. This has been overcome by erecting a two-story shed and connecting the second floor with the streets on top of the bluff by the construction of a viaduct over the railroad tracks. The project is intended to serve as a water gate to the retail section of the city and as a waterfront adjunct to the public market system.

The plan provides a two-story shed on three sides of a concrete warehouse. At the northerly end of the in-

provement is a protected basin provided with floats and other facilities for the accommodation of motor boats, where produce from the Puget Sound country can be landed at any stage of the tide.

The dock is equipped with three Barlow marine elevators, by means of which local side port steamers can be unloaded at all stages of the tide and the goods trucked direct to the second as readily as to the first floor. One of the elevators serves the system of floats in the Motor Boat Basin. The concrete building now under construction back of the wharf is 80x400 ft. and five stories high. A section at the north end is set aside for cold-storage purposes. The remaining portion of the building is designed as a general warehouse, except that the fifth floor is planned for the general offices of the Port Commission.

This program, which will be completed during the summer of 1915, will make available berthage, shed and storage space as follows: 15,354 lin.ft. frontage for deep sea vessels; 2100 lin.ft. frontage for local vessels; 541,940 sq.ft. shed area; 268,370 sq.ft. cold-storage floor area (concrete); 500,000 bu. grain elevator; 166,670 sq.ft. lumber storage, and 167,262 sq.ft. concrete warehouse floor area.

This work was designed and constructed under the direction of the writer while he was chief engineer; he was assisted by J. R. West, Engineer in charge of designing, and J. E. Shoemaker, Engineer in charge of construction. J. R. West is now chief engineer.

Track-Clearance Records

By James G. Wishart*

The maximum clearance for trains over the various divisions or lines of a large railway system is a matter of no mean importance. Most railways keep records of the limiting obstructions along their lines, but many of these records lack the detailed information necessary to make them reliable and efficient. Many also lose their real usefulness by being made up in too general a form, simply showing the maximum clearance between terminals or over long stretches of line, although intermediate stations may be the destination of shipments that could be handled to such points while not acceptable over the entire division. Another serious fault with many of these records is the inability to make revisions readily. The revision means practically working over all the records, due to the inability to identify the structures which limit the clearance.

It is a common occurrence for shipments of machinery, bridge steel, etc., of unusual size and shape, to be offered for transportation. Usually they are the source of extra-profitable revenue, and are desirable on that account. But if the road accepting such a shipment is not sure of its ability to transport it safely, it must take the chance of delays and consequent dissatisfaction and complaints of the shipper, as well as danger of damage to the shipment, with resultant settlement of freight loss claims, and possible loss of life and of injury to the company's property.

Where such a shipment is offered, an answer may be wanted in a short time, and where competition is keen the loss of a few hours in determining whether or not it can be safely and promptly handled may result in the loss of the business. In such an instance the railway with the most reliable and complete clearance record is likely to win the business.

A proper record of clearances should have three cardinal characteristics: 1, accuracy; 2, simplicity of arrangement; and 3, sufficiency of detail. A record consisting of a series of tables and diagrams, as shown on the accompanying examples, will fully meet all the requirements outlined above.

To insure accurate and detailed information being taken in the field and recorded in complete form the work of compiling this record should be handled by the engineering department. Standard blank forms should first be made on tracing cloth, and a supply of blue-line prints furnished to each engineer who is to take the field notes. In addition to the instructions carried on the blank, each engineer should be impressed with the fact that every obstruction that comes within 7 ft. of the center of the track and every structure projecting over the track is to be accurately measured and plotted.

To avoid confusion when compiling the permanent record, a separate blank should be used for each obstruction, all dimensions needed for showing its relation to the track and location being shown, as well as the complete description called for in the instructions on the blank. The heavy solid line in Fig. 1 represents the standard clearance, and shows at a glance the relation of the structure to the standard. The dimensions shown are

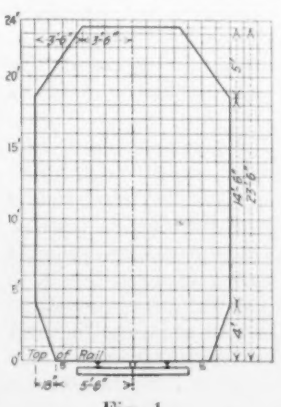


Fig. 1.

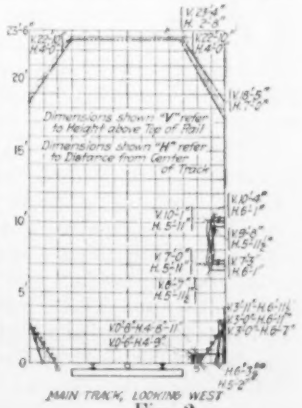

Dimensions shown "V" refer to Height above Top of Rail
Dimensions shown "H" refer to Distance from Center of Track
MAIN TRACK, LOOKING WEST

Fig. 2.

Track-Clearance Record Diagrams; Rock Island Lines

The diagram in Fig. 1 is on the left side of a sheet 14½ x 10¼ in. (inside the border). The right side of the sheet contains instructions as follows:

Fill out carefully all of the following:

Division .....
Main or branch line .....
Mile post..... Bridge No.....
Near (town and state) .....
Kind of structure .....
Side of main track .....
Track .....
Tangent (yes or no) .....
Degree of curve .....
Superelevation of curve .....
Estimated cost to change to standard clearance.....

Show in red on the diagram the outline of the clearance at point named above; using a separate blank for each obstruction and reporting only such as give less than 7 ft. clearance from the center of track.

Minimum vertical clearance to represent the minimum distance between top of rail and nearest point of any tunnel or structure above or across the track.

Minimum horizontal clearance must be shown at all points between the horizontal plane through the top of rail and the horizontal plane through the point of minimum vertical clearance.

Attention must be called to cases where sidings or double track are placed less than 13 ft. c. to c. from the main track.

The diagram in Fig. 2 is placed in a similar position on a sheet of the same size as that shown in Fig. 1. It shows all obstructions within 7 ft. of center of track. Where passing or other tracks are parallel and 13 ft. c. to c. the maximum clearance line is fixed at 6½ ft. from center of track.

*Chief Draftsman, Rock Island Lines, Chicago.

not intended to represent a recommended standard, but are simply those now in use on a large railway system.

The information when completed for a division or line is plotted on the blanks, which are then forwarded to the office of record (preferably that of the chief engineer) where the permanent record is compiled and kept on file. The permanent record is made up on tracing-cloth sheets 11x17 in., bound in loose-leaf binders. The most suitable form of binder is a spring-back binder with stiff covers, which permits of readily removing any sheet and requires no perforations.

This sheet being double the size of the standard letter sheet, is convenient for mailing and also permits of plotting the diagrams on a scale of ⅜ in. per ft., which is sufficiently large to allow small irregularities in the contour of the obstruction to be plainly shown and prevents confusion of lines when plotting several structures with similar dimensions on the same sheet. The information from six or seven of the blanks returned from the field is plotted on one sheet in the permanent record. A distinctive style of line is used for each obstruction, and a full description of each obstruction is also shown on the same sheet in the upper right-hand corner, being arranged in mile-post order (Fig. 2).

In compiling the sheets in the field it is important that the track alignment be correctly entered at each obstruction, and that on a curve the degree of curve and superelevation of rail be shown. This information is especially important when shipments of extraordinary length are being considered.

For quick reference, the data from these sheets are compiled in tabular form (as shown in the table), giving the minimum horizontal clearances at heights varying by one foot from the top of rail to as high as it is thought desirable to carry them. In compiling these tables mail cranes are not taken into account, as they do not form a permanent obstruction, although they are shown on the diagram sheets with mail bag in position.

These clearances are shown for consecutive sections of the line, the territory covered by a sheet varying according to the number and distance apart of the obstructions. One horizontal space in the table is given to each sheet of diagrams, the number in the column headed "page" referring to the page carrying the diagrams covered by the figures in that line. At the bottom of the columns or at the end of each division or line of the road, a summary is shown giving the minimum clearance over the entire length.

In most cases it is only necessary to refer to the tables to determine the clearance on a shipment. Where a doubt arises one can turn to the page showing the obstruction at the doubtful point, and from the description on that page a decision can be made.

Such a record when once compiled should be kept strictly uptodate. Blueprints of the complete diagrams and tables for their respective divisions should be furnished to all officers, and they should be impressed with the importance of making special reports of any changes which affect the record so that the office of record may promptly revise the tracings and issue new prints.

MAXIMUM CLEARANCE TABLE

Chief Engineer's Office, March, 1913

Maximum Widths at Heights Shown—Heights Above Top of Rail

Burlington to Minneapolis	Page	Top of Rail ft.in.	1 ft.in.	2 ft.in.	3 ft.in.	4 ft.in.	20 ft.in.	21 ft.in.	22 ft.in.	23 ft.in.	23-6 ft.in.	Max. Height ft.in.	Max. Width at M. Hgt. ft.in.	Remarks
Cedar Rapids Division														
Burlington to Mediapolis	82	9-0	10-6	11-6	12-6	13-0	9-8	8-0	8-0	8-0	8-0	N. L.	8-0	Burlington tank spout.
Mediapolis to Bard	83	10-0	11-0	12-0	13-0	13-0	4-2	...	...	...	...	20-10	4-2	Br. 317 and Wapello spout
Bard to Centerdale	84	9-2	10-4	11-0	11-6	12-2	4-4	4-4	...	...	...	20-0	4-4	Br. 413 and Nichols spout
Centerdale to Elmira	85	10-0	10-6	12-3	13-0	13-0	3-8	3-8	3-8	3-8	3-8	N. L.	3-8	Elmira spout
Elmira to Putlege	86	9-8	10-4	12-0	13-0	13-0	13-0	...	...	...	...	20-0	13-0	Highway Br. overhead
Putlege to Cedar Rapids	87	10-0	11-0	12-0	13-0	13-0	9-0	...	...	...	...	20-8	7-8	Br. 962
Max. Clear. M. L. Ced. Rap. Div.	..	9-0	10-4	11-0	11-6	12-2	3-8	...	...	...	...	20-0	3-8	
Minnesota Division														
Cedar Rapids to Shellsburg	88	10-2	11-0	12-4	13-0	13-0	13-0	...	...	...	...	20-2	13-0	C. M. & St. P. overhead
Shellsburg to La Porte City	89	9-0	10-6	11-8	12-8	13-0	13-0	13-0	...	...	...	21-7	13-0	
La Porte City to Waterloo	90	8-10	9-8	10-6	11-4	12-4	13-0	12-0	10-2	...	...	22-1	10-0	
Waterloo to Clarksville	91	9-10	10-8	11-8	12-6	13-0	...	...	...	...	...	19-9	4-4	Br. 1777 and Shell Rock spout

The Chicago Plan and the New Heavy-Traffic Streets

By Walter D. Moody*

Through the efforts of the Chicago Plan Commission, the city of Chicago is taking steps to create a new traffic clearing base about the city's center. One of the developments in the Plan of Chicago is a provision for a complete system of street circulation. This is intended to facilitate the movement of traffic to and from the center of the city and between the various outlying sections, and to connect these latter with the central district. It is to be accomplished through the widening and improvement of existing streets, and the creation of new thoroughfares, including many diagonal arteries. The general scheme is shown by the accompanying cut.

The basis of the street circulatory system is what is known in plan parlance as the quadrangle. Traffic conditions indicate that the four streets comprising this quadrangle are destined to bear the heaviest traffic in the future city. Plans have been made, therefore, for their widening, extension and improvement. The four streets comprising the circuit around the heart of the city are Michigan Ave., 12th St., Canal St. and Chicago Ave. As Chicago Ave. (the northern line of the quadrangle) is 100 ft. wide, it is sufficient to properly care for the traffic on that thoroughfare.

12th St. Improvement—The first work undertaken by the Chicago Plan Commission was the improvement of 12th St., which at present is 66 ft. wide. From Ashland Ave. it is to be widened to 108 ft. for 1½ miles and to 118 ft. for the rest of the distance to Michigan Ave., about ½ mile. For this purpose land is to be taken from the property along the south side of the street. From Canal St. to Wabash Ave. (one block from Michigan Ave.) there will be a fine viaduct, crossing the railways and the river. This will be the full width of the street, 118 ft.

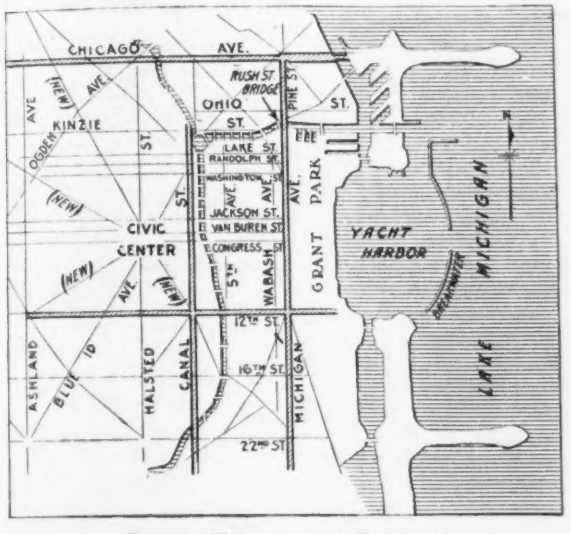
The total cost will be about $4,500,000, divided as follows: The value of land and buildings to be taken, as determined by the court commissioners, is $3,000,000. Of this amount, 50% has been provided for by the approval of the people of a bond issue to cover the amount

*Managing Director, Chicago Plan Commission, 10 No. LaSalle St. Chicago.

of public benefit. The other 50% is to be provided by special assessment upon the property benefitted, which covers an area of 10 sq.mi. The 118-ft. viaduct will cost approximately $950,000; of this the railways have agreed to pay $791,350 and the city will pay the small balance. The cost of the bridge across the Chicago River, $48,000, will be divided equally between the city and the Sanitary District. The bridge is to be of the vertical-lift type and is to be 84 ft. wide.

The special assessment roll was filed in the Superior Court on Nov. 27, 1914. The summonses in this suit were returnable during January of this year, and it is expected that the case will be set for trial by condemnation shortly thereafter.

MICHIGAN AVE. IMPROVEMENT—The Chicago Plan Commission next gave consideration to the proper development of the Michigan Ave. boundary of the quadrangle. This street, which borders the downtown district on the east for a distance of one mile in the center of the city (from Park Row—of the new 12th St. extension—north



STREET WIDENING IN CHICAGO

(Outline of revised street layout of Chicago as proposed by the Chicago Plan Commission, showing the quadrangle of heavy-traffic streets around the central District).

to Randolph St.) is one of the finest business arteries in any world city. The facades of the buildings along the western side of the street, and the boulevard outlook across Grant Park east to Lake Michigan, are distinguishing features of this thoroughfare. There are no buildings between the street and the park. This fine development stops at Randolph St., beyond which Michigan Ave. extends as a 66-ft. business street north to the river.

The north and south sides of Chicago are now to be properly connected through the widening and expansion of Michigan Ave. for a mile north of the loop district, beginning at Randolph St. This improvement is to be made on a two-level plan, the upper level (to be continued as Michigan Ave.) for light and fast traffic, and the lower level for heavy traffic. The separation of traffic will be accomplished by this means, as east- and westbound traffic may pass (at the present grade) beneath the upper level without interfering with the high-speed north-and-south traffic of the boulevard. There are about 60,000 vehicles traversing and crossing Michigan Ave. in this zone every twelve hours of the working day; 75% of this is north-and-south, and 25% is east-and-west traffic emanating from the freight yards, boat terminals and industrial district along the lake front and downtown.

Michigan Ave. today terminates at the Chicago River. From the river to Randolph St. it is 66 ft. wide; south of this it is 130 ft. wide, which width is to be carried north to the river. Pine St. from the north side of the river to Chicago Ave. is to be widened from 66 to 141 ft. The two streets are to be made one and connected by a double-deck bascule bridge, 210 ft. span, with a width of 90 ft.* In this way the east boundary of the traffic quadrangle will be completed.

The widening will take 61½ ft. from the east side of Michigan Ave. from Randolph St. north to the river, and 75 ft. from the west side of Pine St. from the river north to Chicago Ave. The upper level will extend for nearly a mile between Lake and Ohio Sts. and will be the full width between building lines. All buildings will have their entrances, shop windows, etc., on the upper or boulevard level. The lower or present level will be used for receiving and shipping purposes. By this plan existing grades will be reduced, and traffic facilities thereby improved. There will be easy approaches to the upper level, the grade being slightly over 2% on the south and 3% on the north side.

The court commissioners appointed in this case valued the land to be taken at $3,790,229; damage to existing buildings, $1,541,954; damage to machinery, $222,275; damage to property not taken, $100,000; the two-level bridge and roadway, $2,298,247. The total is slightly under $8,000,000. The city's share of the cost, $3,800,000 (to be realized by the sale of public bonds), was voted by the people by a majority of 78,846. Court proceedings to take the land will soon be started.

IMPROVEMENT OF CANAL ST.—The western side of the quadrangle, Canal St., is to be improved in connection with the west side railway terminal development. Late in 1912, a group of railways on the west side made public a plan for new terminal facilities in that section of the city, to cost $65,000,000 and including the reconstruction of the present Union Station. During the negotiations between the railways and the city the Chicago Plan Commission acted in its capacity as advisor to the City Council. In addition to a large cash compensation to be paid to the city, numerous concessions were made by the railways for the street, bridge and viaduct improvements to be made simultaneously with their terminal development, and to be finished within five years.

Among the improvements to be made by the railway is the widening of Canal St. as noted above. It will be widened from 80 ft. (its present width) to 100 ft., and made to connect on a double-deck level with 12th St. on the south, and with the north side by a double-deck bridge at Kinzie St.

This outer quadrangle of streets will afford quick and convenient access for traffic between the west, north and south sides of the city, by enabling it to avoid the congested central district. Great relief will also be afforded Chicago's congested "loop" district (Van Buren St., Lake St., Wabash Ave. and 5th Ave.) by the removal of such traffic to these more convenient routes. The improvements involved in the completion of the quadrangle and the west side terminals will cost nearly $80,000,000.

*This bridge was described in "Engineering News," July 17, 1913.

The Sewage-Works of Marysville, Ohio

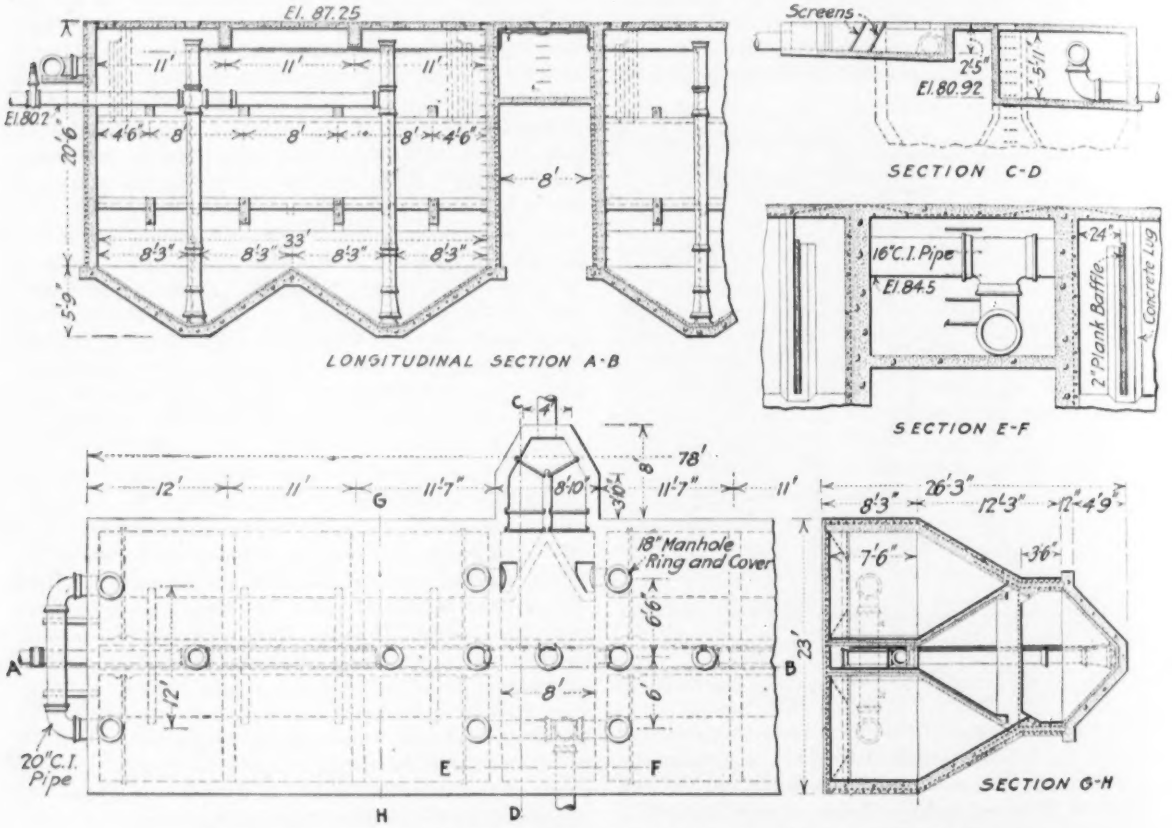
A sewage-treatment plant designed to produce an effluent of an unusually high degree of purity was completed by the village of Marysville, Ohio, late in 1914. The plant consists of bar screens, two-story tanks, control chambers, contact beds and intermittent sand filters. It is located not far above the intake of the purification works of the water-supply of Columbus, Ohio.

The population of Marysville in 1910 was 3576 but the sewage-works have been built to take the sewage of 6000 people at the rate of 80 gal. per capita, including 300 now and 1000 ultimately in the new Woman's Reformatory, which has been connected with the city outfall sewer.

a total area of about ¾ acre. The beds are of concrete, and are filled to a depth of 4 ft. with blue limestone from Dunkirk, Ohio. For distributors full diameter vitrified pipe with open joints are used, so laid that the top of the pipe is flush with the top of the stone.

The four sand filters are each 175x125 ft. or one acre in area, separated by concrete walls, and filled to a depth of 2 ft. by lake sand from Sandusky, Ohio, supplied by the Kelly Island Lime & Transport Co. Distributing troughs of wood extend around the walls and lengthwise of the sand filters. A gravel-filled sludge bed receives the tank sludge.

Surrounding the sewage-works is a dike which is 15 ft. high in places. A centrifugal pump with an 8-in. suction and a 6-in. discharge is provided to pump out storm water from the inclosure whenever the creek is too high to let



TWO-STORY SETTLING TANK FOR THE SEWAGE-WORKS OF MARYSVILLE, OHIO

Marysville is on Mill Creek, which at Marysville has a drainage area of about 85 sq.mi., a minimum discharge of 3 to 5 cu.ft. per sec., and a population, above the city, of about 2500.

Mill Creek joins the Scioto River, some 10 mi. below Marysville, at a point 6 to 8 mi. above the upper end of the storage reservoir of the Columbus water-works, and 16 to 18 mi. above the Columbus water-works intake. The distance from the sewer outlet to the water intake is thus 26 to 28 mi.

After passing ordinary bar screens the sewage goes to twin two-story tanks (see accompanying illustration) and then to control chambers in which there are four Miller automatic siphons. The siphons discharge the tank effluent onto four contact beds, each 90 ft. square, giving it flow out by gravity. There is a check valve to prevent a back flow from the creek.

The approximate cost of the sewage-works, including the dike, was $55,000. R. W. Pratt, Hippodrome Building, Cleveland, Ohio, was consulting engineer in charge of design and construction. Alvi Graham was city engineer and E. D. Barstow was resident engineer. Epps & Milligan, of Marysville, were the contractors.

Not a Passenger Was Killed by negligence on the Boston elevated railway lines and there were no fatal accidents on the elevated or subway trains of the company during the year ending June 30, 1914, according to the records of the company. During the period named, the company carried 343,000,000 revenue passengers and 270,000,000 transfer passengers and ran a total of 59,000,000 car-miles.

Wind-Bracing Requirements in Municipal Building Codes

By R. Fleming*

SYNOPSIS—How 120 American cities specify wind pressure for the design of buildings. Great range of pressures and working stresses. Recommendation that 20 lb. per sq.ft., and for combined stress 50% increase in working stress, be adopted as standard.

The assumptions that are made for wind pressure and working stresses due to wind loads play an important part in the design of a many-storied hotel or office building. These are seldom left to the judgment of the designer, but are determined by the building code of the city in which the building is located.

According to the census of 1910 there were in the United States 50 cities each having a population over 100,000. The building codes of 45 of these cities, together with those of about 75 cities below 100,000, have been examined with respect to their requirements for wind bracing. The purpose of this article is to show the wide variation in requirements in these codes, and to make a plea that assumptions be made more nearly uniform.

The present Building Code of the City of New York, affecting more building operations than that of any other city on the continent, was adopted in 1899. The Board of Aldermen passed a new code in 1909, after extended discussion and bitter controversy, but the Mayor vetoed it. The present code is archaic in some of its provisions and is inadequate for present needs. It has been used as the basis for the codes of a host of other cities. Sometimes it has been copied with but little change, and in other cases some sections have been modified or rejected.

Regarding wind pressure the New York code requires that all structures exposed to the wind (except those under 100 ft. in height in which the height does not exceed four times the average width of the base) be designed to resist a horizontal wind pressure of 30 lb. in any direction for every square foot of surface exposed from the ground to the top, including the roof. Regarding unit-stresses the code reads:

> In calculations for wind bracing, the working stresses set forth in this code may be increased by 50%.

This sentence is ambiguous as it does not state whether the high unit-stress is applicable to the combined stresses due to wind and other loads or whether it is to be used for the wind stress only. There is considerable difference between the two interpretations as to the amount of material required in bracing a high and narrow building. The Chicago code removes all doubt by specifying:

> For stresses produced by wind forces combined with those from live- and dead-load, the unit-stress may be increased 50% over those given above; but the section shall not be less than that required if wind forces be neglected.

It may be said that the practice in New York and elsewhere is to interpret the 50% as applying to combined stresses.

Another sentence in the New York code reads:

> In all structures exposed to wind, if the resisting moments of the ordinary materials of construction, such as masonry, partitions, floors and connections, are not sufficient to resist the moment of distortion due to wind pressure, taken in any direction on any part of the structure, additional bracing shall be introduced sufficient to make up the difference in the moments.

Good practice does not permit and it is not common to carry the wind stresses in steel buildings either in whole or in part to the ground by walls or partitions. The Bridgeport code has a clause which should be followed, reading:

> In buildings of skeleton construction the frame must be designed to resist this wind pressure.

Manchester, Albany, Utica, Jersey City, Paterson, Terre Haute, Kalamazoo, Milwaukee, St. Paul, Minneapolis, Louisville, Tampa, Atlanta, Dallas and Tacoma all follow the New York code regarding wind bracing except for an occasional variation for buildings under 100 ft in height.

In Philadelphia a pressure of not less than 30 lb. per sq.ft. is called for on all buildings erected in open spaces or on wharves. On tall buildings erected in built-up districts the wind pressure is not to be figured for less than 25 lb. at tenth story, 2½ lb. less on each succeeding lower story, and 2½ lb. additional on each succeeding upper story to a maximum of 35 lb. at the fourteenth story and above. In proportioning members subject to stresses due to wind loads the working stresses may be increased 30%. In Washington buildings are practically limited to twelve stories in height. The prescribed wind pressure is the same as in Philadelphia, but no mention is made of any increase of working stresses. Lowell, Bridgeport, Baltimore, Buffalo and Sioux City assume wind pressure at 30 lb. per sq.ft. and are also silent on the subject of working stresses being increased.

Pittsburgh calls for 25 lb., Detroit and Jacksonville 30 lb. per sq.ft. wind pressure, and each allows the working stresses to be increased 25%.

Cincinnati requires provision to be made for a pressure of 20 lb. per sq.ft. for the surface exposed above surrounding buildings; working stresses may be increased 25% St. Louis assumes a pressure of 30 lb. per sq.ft. and allows an increase of 20% to working stresses. The St. Louis code has this provision:

> Where there are buildings immediately adjoining, the wall surface covered by such buildings will be considered as not exposed to wind pressure.

The question might be asked concerning buildings in Cincinnati and St. Louis as to what would take the wind pressure if the surrounding buildings were removed.

Chicago, San Francisco, Covington and Akron call for 20 lb. per sq.ft. wind pressure. An increase of 50% to the working stresses is allowed in Chicago and San Francisco, 25% in Covington and none in Akron.

Poughkeepsie, Evansville and Chattanooga call for 30 lb. per sq.ft. horizontal wind pressure and state as follows:

> The additional loads caused by the wind pressure upon beams, girders, walls and columns must be determined by

*American Bridge Co., 30 Church St., New York City.

calculation and added to other loads for such members. Special bracing shall be employed wherever necessary to resist the distorting effect of the wind pressure.

No mention is made of higher unit-stresses for wind loads.

Syracuse, Erie, Cleveland, Duluth, Denver, Macon, Birmingham and Portland (Oregon) for all buildings whose heights exceed 1½ times the width of the base follow the wind pressures given in the Philadelphia code. The Syracuse code alone allows an increase of working stresses—25%. Each code has this provision:

Every panel in a curtain wall shall be proportioned to resist a wind pressure of 30 lb. per sq.ft.

The code of Grand Rapids copies the Schneider "Specifications for Structural Work of Buildings." The wind pressure is assumed as acting horizontally in any direction, as follows:

First—At 20 lb. per sq.ft. on the sides and ends of buildings and on the actual exposed surface, or the vertical projection of roofs.

Second—At 30 lb. per sq.ft. on the total exposed surfaces of all parts composing the metal framework. The framework shall be considered an independent structure, without walls, partitions or floors.

For bracing and the combined stresses due to wind and other loading, the permissible working stresses may be increased 25%, or to 20,000 lb. for direct compression or tension.

The code of Memphis has the same provisions though differently worded.

The code of Oakland is unusually explicit in the treatment of wind bracing. For buildings of Class A over 100 ft. high, or where the height exceeds three times the least horizontal dimension, or for buildings of Class B over 80 ft. high where the height exceeds two times the least horizontal dimension, it provides:

The steel frame shall be designed to resist a wind force of 30 lb. per sq.ft. acting in any direction upon the entire exposed surface. All exterior wall girders shall have knee-brace connections to columns. Provision shall be made for diagonal, portal or kneebracing to resist wind stresses, and such bracing shall be continuous from top story to and including basement.

An increase of 50% above the allowed dead- and live-load stress shall be used for wind stress. Columns subjected to cross-bending by wind or eccentric loading shall have additional area to provide for the stresses, the eccentric loading being calculated as dead-load and the wind provided above. The area of metal thus obtained for wind, cross-bending and eccentric loading shall be added to the area provided for dead- and live-load to obtain the total metal in column.

In the case of reinforced-concrete buildings where provision must be made for wind pressure, there is this provision:

The reinforcing rods of columns shall be connected by threading the rods and by threaded sleeve nuts or threaded turnbuckles, or methods equally effective and satisfactory to the Bridge Inspector.

In Salt Lake City for buildings over 102 ft. high, or where the height exceeds three times the least horizontal dimension, "the steel frame shall be designed to resist a wind force of 20 lb. per sq.ft. in any direction upon the entire exposed surface." As in Oakland, it is required that the exterior wall girders shall have knee-brace connections to the columns and that diagonal, portal or kneebracing to resist wind pressure shall be used from the top story to and including basement. Unlike Oakland no increase of working stresses for wind loads is mentioned.

The code of Waltham, Mass., has the provision:

All buildings exposed to the wind shall be calculated to resist a pressure on either side so exposed, and upon the roof, if pitched, amounting to 10 lb. per sq.ft. of vertical projection of roof between the ground and a height of 40 ft. above the ground, a pressure of 15 lb. per sq.ft. on parts between 40 and 60 ft. above the ground, and 20 lb. per sq.ft. on parts 60 ft. above the ground.

No increased working stresses for wind are mentioned.

The code of Columbus, Ohio, adopted ten years ago, reads the same on wind pressure as the New York code except that working stresses may be increased 25% instead of 50%. There is added the sentence:

In buildings constructed of structural steel the wind pressure shall be allowed for as follows: Ten lb. per sq.ft. of exposed surface for buildings 20 ft. or less to the eaves; 20 lb. per sq.ft. of exposed surface for buildings 60 ft. to the eaves; 30 lb. per sq.ft. of exposed surface for buildings over 60 ft. to the eaves.

The codes of Boston, Cambridge, Haverhill and New Orleans have the sentence: "Provision for wind bracing shall be made wherever it is necessary." This is indefinite and tends to put a premium on ignorance. If all designers were experts there would still be enough difference of opinion as to the amount of wind bracing necessary. But a design with little or no wind bracing is also entitled to consideration if the maker gives assurance that he is furnishing bracing "wherever it is necessary." The same might be said concerning the codes of New Haven, Providence, Worcester, Springfield, Wheeling, Youngstown, Toledo, Omaha, Lincoln, Montgomery, Fort Worth, Los Angeles and others, which while giving loads and stresses for structural steel generally say nothing on the subject of wind pressure. Indianapolis and Seattle allow an increase of 50% to the working stresses but do not state the amount of pressure.

The codes of Fall River, Pawtucket, Elizabeth, Allentown, Altoona, Fort Wayne, Dubuque and Topeka are very meager or altogether silent on the whole subject of loads, stresses, and structural steel.

Codes often contain blanket clauses which might be used to cover a wide range of omissions—thus, Cleveland, Duluth, Little Rock, Fort Worth and others say:

The allowable factor or units of safety or the dimensions of each piece or combination of materials required in a building or structure, if not given in this ordinance, shall be ascertained by computation according to the rules prescribed by the modern standard authorities on strength of material, applied mechanics and engineering practice.

Erie, Pa., has the sentence: "In general all stresses shall be figured *in accordance with the standard specifications of the American Society of Civil Engineers.*"

The New Haven code reads:

The dimensions of each piece or combination of materials required shall be ascertained by computation according to the rules and data given in Haswell's Mechanics' and Engineers' Pocket Book, Trautwine's Engineers' Pocket Book, or Kidder's Architects' and Builders' Pocket Book, except as may be otherwise provided in this title. Stresses for materials and forms of same not herein mentioned shall be those determined by the best modern practice.

The last code from which quotations will be made is that of the largest city in the world. The London County Council (General Powers) Act, 1909, in Section 22, "Provisions with respect to Buildings of Iron and Steel Skeleton Construction," requires:

All buildings shall be so designed as to resist safely a wind pressure in any horizontal direction of not less than 30 lb. per sq.ft. of the upper two-thirds of the surface of such buildings exposed to wind pressure.

Working stresses exceeding those specified "by not more than 25% may be allowed in cases in which such excess is due to stresses induced by wind pressure."

Conclusion

It might seem from the foregoing that our American municipalities have exhausted the combinations of wind

pressure and wind stress that can be made. The fact that one code differs from another is not in itself a cause for criticism, but a code is decidedly at fault when it contains absurd or needless requirements or when its requirements are not clearly expressed. To assume wind pressure over a large area at 30 lb. per sq.ft. and then to add the sectional area necessary to resist wind stresses to that required for live- and dead-loads is needless. Where this is specified in a code it is evaded in practice. It would be far better to make rational assumptions and insist on a rigid adherence to them, than to insert in a code improbable loadings or working stresses that will be ignored in actual construction.

That the need of revision in our building codes is being felt by the public is evidenced by the number now being revised. Although our knowledge of wind action is limited we should be able to come nearer to a common ground of requirement for wind bracing than we have at present. As a basis for uniformity the writer suggests the building ordinances of Chicago. The paragraph on Wind Resistance reads:

> All buildings shall be designed to resist a horizontal wind pressure of 20 lb. per sq.ft. for every square foot of exposed surface. In no case shall the overturning moment due to wind pressure exceed 75% of the moment of stability of the building due to the dead load only.

The paragraph relating to Wind Stress, previously quoted, reads:

> For stress produced by wind forces combined with those from live- and dead-loads, the unit-stress may be increased 50% over those given above; but the section shall not be less than required if wind forces be neglected.

Records of Service of Cast-Iron Water Pipe

The recent breaking of a 30-in. water main* which formed a part of the original distribution system of the Croton water-supply of New York City, installed 60 to 70 years ago, again brings to the front the interesting fact that there are still many miles of cast-iron water mains in our older Eastern cities, which date back to the beginning of the municipal water-works era in America.

In Philadelphia, the first American city of any size to have a municipal water-works, there is yet a considerable mileage of cast-iron pipes installed between 1817 and 1830 as parts of the famous Fairmount water-works. These pipes were imported from England, but at the time the Croton water-supply was established in New York there was a considerable pipe-founding industry in this country, and presumedly the old New York mains are chiefly of American manufacture.

The accompanying illustration shows a piece of the pipe removed from the broken main at Eighth Ave. and 42nd St., New York City, already referred to. As noted in a previous issue of ENGINEERING NEWS, the pipe in all probability was broken by the impact of the street cars passing over it. The broken section exhibited no material deterioration; as the illustrations shows, the interior incrustation was very shallow, and the ¾-in. thickness of the pipe had not been appreciably reduced by rust, notwithstanding the fact that the pipe was probably never painted or protected in any way. This thickness is less than that at present required for the lowest class (class A) of the New England Water Works Association, which is 0.88 in. for a 30-in. pipe.

The use of cast-iron water pipe in Europe dates back to the 17th century, and according to M. R. Pugh,† of Philadelphia, there are still in use about 26,000 ft. of cast-iron water mains, laid by order of Louis XIV of France, to supply the town and parks of Versailles, between 1664 and 1688, or from 226 to 250 years ago. The mains which supply the great fountains of Versailles, and mains connecting various reservoirs, aggregating 27,500 lin.ft., are something like 229 years old. The water-works of London and Glasgow have records of cast-iron water mains which were in service for 120 years.

BROKEN SECTION OF 30-IN. CAST-IRON WATER MAIN OF OLD CROTON WATER-SUPPLY SYSTEM, NEW YORK CITY

Mine Drainage Pumps in the anthracite district of Pennsylvania have a total capacity of 1,037,000 gal. per min. This capacity provides an ample margin to cover breakdowns, repairs and periods of heavy percolation in the mines. The quantity of water actually pumped from the mines last year was about 250,000,000,000 gal., giving an average rate for the entire year of 489,600 gal. per min. The quantity of water handled has increased nearly 10% in the last ten years and will continue to increase until the mines are worked out. The quantity of water lifted from the mines was about 13½ times as great as the quantity of coal hoisted.

*See "Engineering News," Feb. 11, 1915, p. 286.

†In a paper "External Corrosion of Cast-Iron Pipe," "Proceedings" of the American Society of Civil Engineers, August, 1914.

New Railway Passenger Terminal at St. Paul, Minn.

The reconstruction and rearrangement of the union passenger railway station at St. Paul, Minn., has been under consideration for several years. The adoption of definite plans has been delayed, however, by the difficulty of effecting agreement between the nine railway companies and the municipal and other interests involved. The burning of the old station building on Oct. 3, 1913, gave an unexpected impetus to the work. In January, 1915, plans for a new station and terminal were submitted to the city authorities by the St. Paul Union Depot Co., which owns the terminal property and in which the several railways are represented. These plans were approved by the City Council on Feb. 6, 1915. The total cost of the project is estimated at $15,000,000.

through tracks, besides four through tracks for freight trains. All the tracks will be raised to the same level at the station, but the freight tracks will have grades descending in each direction from Sibley St., so as to pass under the passenger tracks instead of crossing them at grade, as in the present terminal. This arrangement is shown by the profiles in Fig. 1.

A general plan of the station and its track layout is

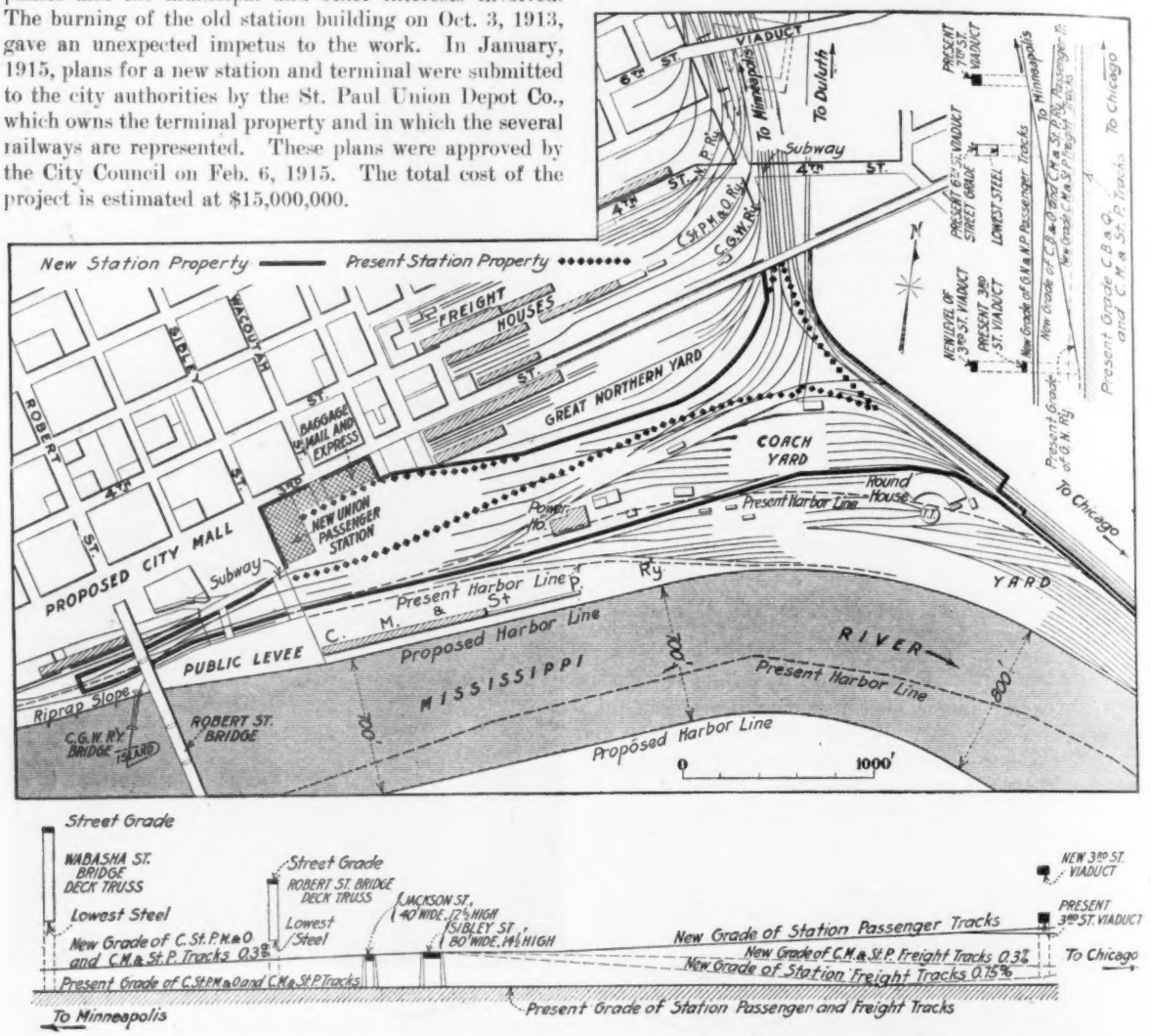


FIG. 1. PLAN OF THE NEW RAILWAY TERMINAL AND UNION PASSENGER STATION AT ST. PAUL, MINN., SHOWING THE PROPOSED DIVERSION OF THE MISSISSIPPI RIVER

One of the fundamental difficulties was to find the necessary area for enlarging the terminal, the present site being a narrow strip of ground between the Mississippi River and high bluffs. There is low land on the opposite side of the river, and the plan adopted was to shift the river about 200 ft. southward to a new channel, and to fill and reclaim the intervening space as made-land for the new terminal. The reclamation will be 300 to 400 ft. wide, and will extend for a distance of about a mile. This rectification of the river channel is indicated in Fig. 1. It was authorized by Congress in 1911, subject to the approval of the War Department.

The station is arranged with 16 stub tracks and 10 given in Fig. 2. The station building will be 315x320 ft. Its first floor will be level with the intersection of Sibley and 3rd Sts., and with the main train concourse at the end of the stub tracks. Access to the island platforms of the through tracks is afforded by steps leading from the end of the main concourse to a concourse beneath the tracks (at the basement level), from which there are stairways and elevators to the train platforms. Passengers coming from the through trains descend to this concourse, from which there is direct access to the carriage concourse at the basement level and opening into Sibley St. This street is carried under the tracks by a subway.

The platforms for stub and through tracks will be 1000 to 1200 ft. long, and about 28 ft. wide. They will be protected probably by shelters of the butterfly type, extending the full length of the platforms. The new station is planned to accommodate about 600 trains daily. The present traffic is about 216 trains, as follows: Originating trains, 62; terminating trains, 62; through trains, 92. As each through train involves two movements, the total number of trains may be taken as 308. This is independent of shifting movements and extra trains. Of these, 61.4% are through the north entrance, 25.3% through the west entrance and 13.3% through the east entrance. The busiest hour is 8 to 9 a.m., when 15 trains arrive and 20 depart.

A municipal improvement proposed by the Mayor to improve the accessibility and appearance of the station is to establish an open space or City Mall extending west from the station building to Wabasha St. (three blocks beyond Robert St., Fig. 1), and occupying the space between the tracks and 3rd St. It is proposed further that the new river front between the station and Robert St. should be held as a municipal levee, owned by the city.

The station building will have two stories and a basement. It will be of granite for the lower portion and Bedford stone above, with red tile roof. The first floor (Fig. 2) will contain the principal station facilities. The main waiting room is 195x90 ft., with a ticket office 100 ft. long, having windows on both sides. On each side of this will be doorways opening upon the concourse, 304x59 ft. The basement will contain the carriage concourse and entrance, low-level concourse (198x 41 ft.), baggage rooms, and a trucking space.

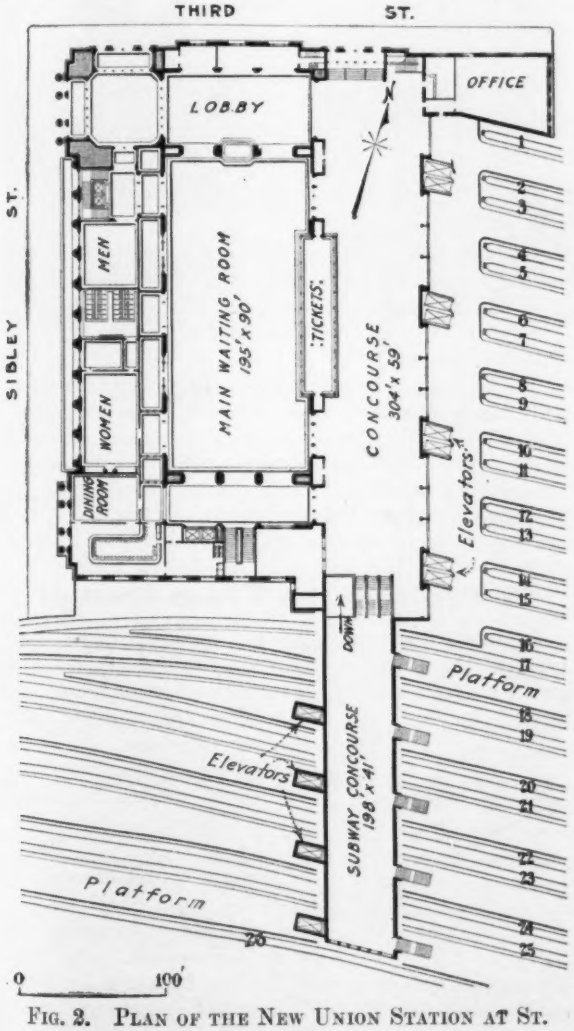


FIG. 2. PLAN OF THE NEW UNION STATION AT ST. PAUL, MINN.

All baggage will be handled at the basement level, and a floor area of about 20,000 sq.ft. has been provided for this in view of the great amount of baggage transfer service. A trucking subway extends the length of the trainshed to a transverse subway at Broadway St., where elevators serve the train platforms. Mail and express matter will be handled in the same way.

The first work to be undertaken will be the changing of the river channel and the filling for the new site. It is estimated that when the plans have been approved, the work on the river can be done in 15 to 18 months, and the entire station and terminal completed in about four years. The length of time required is due partly to the fact that all the work is on and adjacent to the present terminal, which must, of course, be maintained in regular service during the reconstruction.

A comparison of some of the main features of the old and new stations is given in the accompanying table:

COMPARISON OF THE OLD AND NEW UNION STATIONS, ST. PAUL, MINN.

	Old Station	New Station
Station property, acres	17.2	54.2
Track, miles	9.2	24.9
Number of passenger tracks	14	26
Number of freight tracks	2	4
Passenger building, sq.ft.	30,000	69,000
Waiting room and concourse, sq.ft.	14,500	41,000
Baggage, mail and express, sq.ft.	17,230	66,000
No. of bag., ml. and exp. elevators	1	24
Coach yard, cars	100	218
City levee, acres	1.3	3.9
Min. width between harbor lines	650 ft.	700 ft.
Sibley St. crossing, tracks	5, at grade	14, in subway

The plans of the St. Paul Union Depot Co., described above, were prepared by a committee of three engineers: Ralph Budd, Assistant to the President of the Great Northern Ry.; Charles W. Johnson, Chief Engineer of the Chicago, St. Paul, Minneapolis & Omaha Ry., and Charles F. Loweth, Chief Engineer of the Chicago, Milwaukee & St. Paul Ry. They were examined and approved also by John F. Wallace, consulting engineer. The architect for the building is Charles S. Frost, of Chicago. The St. Paul Union Depot Co. has engaged W. C. Armstrong (Engineer of Bridges, C. & N. W. Ry.) as Chief Engineer, to take charge of the new work. The engineers' committee of three members, noted above, which has had the matter in hand for two years, has been made a permanent committee for consultation with the chief engineer on the various phases of the work. Mr. Budd is Chairman of this committee.

What a Local Engineering Society Should Be—The local engineering society can be, and should be, a success in a business, scientific, social and common sense way. Plan excursions, semitechnical in nature; plan discussion and debate, obtain publicity, fight all the time for recognition of the profession. We cannot all dig canals, tunnel rivers or build ships, but we can hit the high grade under high pressure in our own chosen line and obtain the recognition and prominence our efforts deserve. Learn to express yourselves in debate and in conversation. Be convincing, prove your points in nontechnical language. Bend your efforts to make your profession bigger, better and broader.—J. F. Druar, Consulting Engineer, St. Paul, Minn., in the "Journal of the Association of Engineering Societies."

Field and Office

Easy Calculation of Steam Coal Required by Power Plants

By R. E. Horton*

The writer and his assistants have frequent need to calculate the cost of coal required by actual or hypothetical steam plants under comparison with proposed hydraulic stations. After a few laborious repetitions of computations going back to fundamental factors, the writer standardized his office practice in the interest of general economy and capacity. A table prepared is here given as of possible interest to others.

Computations were carried through and tabulated for the yearly coal consumption in tons at a rate of 1 lb. per hp.-hr. under various conditions. Now it is only necessary to ascertain or estimate and combine (1) the simplest unit coal consumption (per horsepower-hour, including allowance for shrinkage and waste if any); (2) the average horsepower in use when running; (3) the allowance for banking; (4) the hours use per day, and days per year.

FACTORS FOR CALCULATING AMOUNT OF STEAM COAL REQUIRED PER HORSEPOWER-YEAR

Method of Operation	Gross Tons, 2240 Lb. 310 Days	Gross Tons, 2240 Lb. 365 Days	Net Tons, 2000 Lb. 310 Days	Net Tons, 2000 Lb. 365 Days
10 hr. per day, no banking.....	1.38	1.63	1.55	1.83
10 hr. per day plus ⅓ for banking	1.84	2.17	2.07	2.43
12 hr. per day, no banking.....	1.65	1.96	1.86	2.19
12 hr. per day plus ⅓ for banking	2.21	2.61	2.48	2.92
24 hr. per day, no banking.....	3.32	3.91	3.72	4.38

For example: A plant runs 10 hr. per day and 310 days per year, produces 500 hp. average, uses 2½ lb. per hp.-hr. of steam coal, has ⅓ allowance for banking; coal costs $3.50 per gross ton. From the table, the proper unit consumption per horsepower year is 1.84 gross tons. Then,

$$2.5 \times 1.84 \times 500 \times \$3.50 = \$7735 \text{ } \textit{annual cost.}$$

Sometimes it is necessary to know the tons of ash that will have to be disposed of each year; then it is necessary only to substitute the decimal percentage of ash in the coal for the price per ton. For 15% ash the foregoing case shows

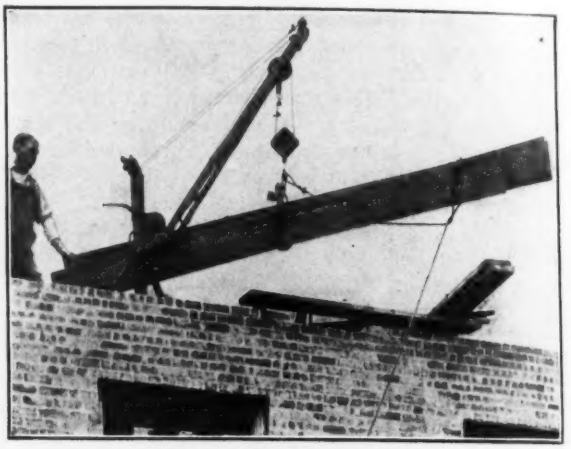
$$2.5 \times 1.84 \times 500 \times 0.15 = 345 \text{ } \textit{gross tons.}$$

⁂

Portable Derrick for Builders and Contractors

The light portable derrick shown in the accompanying illustration is suitable for handling building material, concreting forms, reinforcing rods, etc. It weighs only 225 lb. and has a hoisting capacity of 1000 lb. A special feature is that the boom and hoist can be lifted off the braced post which forms the main part of the mast. This enables one man to move and place the derrick.

The main part of the mast is an iron post 4 ft. high, with a shoe riveted to two horizontal steel channels, from each of which a brace extends to a collar on the mast. The boom is 6 ft. long and can be adjusted to any angle. It is pivoted to a casting which carries the drum, and the back of this casting forms a sleeve which fits over the top of the mast. The sleeve rides upon the collar to which the braces are attached, and its rear end is carried up above the top of the mast, where a drum is attached for the topping-lift cable by which the reach of the boom is adjusted. The sleeve, with boom and hoist, can be revolved through a complete circle, and can be locked at any position.



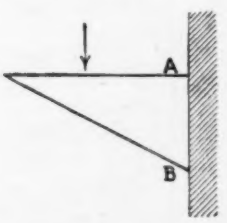
Light Portable Derrick for Builders and Contractors

The hoisting cable may have a hook for direct hoisting or it may be fitted to a block, as shown in the illustration. The drums have a direct pull, with no gearing, and each is fitted with a ratchet and pawl. The lowering is controlled by a band brake. This derrick is built by the H. Channon Co., of Chicago.

⁂

A Problem in Truss Design

An interesting problem is put by Prof. Edgar Marburg, of the University of Pennsylvania. It ought to give a good opportunity for students of engineering—and some older engineers—to exercise their ingenuity.



Problem: A cantilever truss with chord members as shown in sketch carries a single vertical load, as shown. (1) Supply a system of web members by which the upper chord member at *A*, adjoining the support, will be in compression. (2) Supply another system of web members by which the lower chord member at *B*, adjoining the support, will be in tension.

*Consulting Hydraulic Engineer, 57 No. Pine Ave., Albany, N. Y.

Replacing Truss Bridges by Deck Plate-Girders Under Traffic, W. & L. E. R.R.

By Edward U. Smith*

A number of old bridges, consisting of 130-ft. through Pratt trusses, over Short Creek on the east end of the Toledo Division of the Wheeling & Lake Erie R.R. became obsolete on account of the rapid increase in the weight of rolling stock. These bridges were built by the EdgeMoor Bridge Co. and the Toledo Bridge Co. (both now part of the American Bridge Co.) in 1897, and were designed for single track, E-35 loading. The heaviest equipment operated over these spans was a consolidation locomotive very nearly equivalent to a Cooper's E-50 engine, doubleheaded with a consolidation locomotive equivalent to Cooper's E-40 engine. Owing to the increased traffic from the coal fields, the company purchased a number of heavier consolidation locomotives, which are practically equivalent to Cooper's E-60 loading. The new service made replacement of the bridges imperative.

Upon making surveys for the new spans, it was found that successive raises of grade on either side had left them at low points. We also made a study of the rise of water in the stream, and tabulated all the data that we were able to collect back for a period of ten years, also taking measurements of the channel. It was apparent that by bringing the track at the bridges up to grade deck plate-girders could be used, and additional piers placed in the stream would make 65-ft. girder spans possible without increasing the danger from high water.

These girders were designed for Cooper's E-60 loading in the bridge department of the railroad company, and were fabricated by the American Bridge Co. at Ambridge, Penn., and the King Bridge Co. at Cleveland, Ohio. All skew spans were provided with a stringer at the abutment ends in order that the steel would end at right angles to the track. The top flange was designed with one cover-plate full length and one short cover-plate, in order to have the minimum dap in the ties.

Masonry

The Engineering Department decided that all foundations should be carried to rock or be supported on piling. In some instances rock was found, while in others there was a thick stratum of fireclay or sand and gravel. A pile penetration of 10 to 15 ft. was obtained in these locations, at which depth sand and gravel were found. The work of building the piers was successfully completed during the summer of 1913. No new abutments were necessary. The old ones, which were first-class masonry, were in good condition and were revised to accommodate the new girders. The backwalls were entirely rebuilt with plain concrete and the bridgeseats with reinforced concrete.

Unusual Method of Erection

An unusual method was used in erecting the new deck plate-girders and dismantling the old trusses. It had been decided to scrap all the skew trusses. The bridge department and the Ferro Construction Co. of Chicago, contractors for the erection, agreed on the method described in the following.

A specially improvised car was arranged by the contractors. Its main items were: Length over all, 47 ft. 9 in.; one Lambert engine and a three-drum hoist with 10x12-in. cylinders; weight, 39,000 lb.; capacity, 100,000 lb.; boom, 47 ft. long, controlled by lines running over blocks at the top of a 23-ft. A-frame. The boom had a still capacity of 30 tons, and a carrying-out capacity of 20 tons.

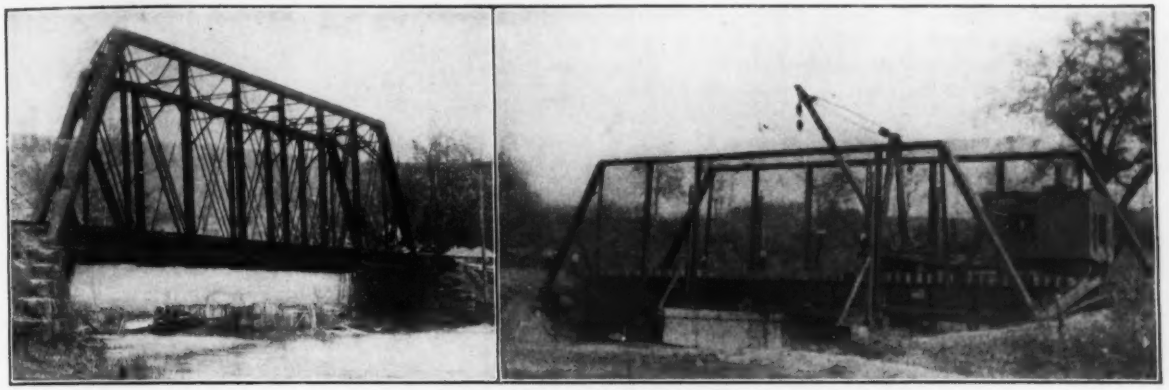


Fig. 1. Two Stages of the W. & L. E. Bridge Replacement

Left View—Old truss bridge of 130-ft. span; work begun on river pier. Right View—New deck girder bridge in place, and trusses being dismembered

Preparatory to the erection of the girders, practically all the rivets connecting the stringers to the floorbeams and the floorbeams to the posts of the trusses were knocked out and replaced with fitting-up bolts. Trains were allowed to pass over the bridges with the connections of the floor system in this condition until all was in readiness for erection. Traffic was light during the months of April and May, 1914, which favored this method of erection. The longest period trains were held, while the first half of the floor system of a 130-ft. struss span was removed and a 65-ft. deck girder placed, was 2 hr. The shortest period trains were held was 1½ hr., while the second half of the floor system was being removed and the second 65-ft. girder span placed.

Fig. 1 shows at the left a one-span truss bridge at the time the last train had passed over it; the work of plac-

*Assistant Engineer, Wheeling & Lake Erie R.R., Cleveland, Ohio.

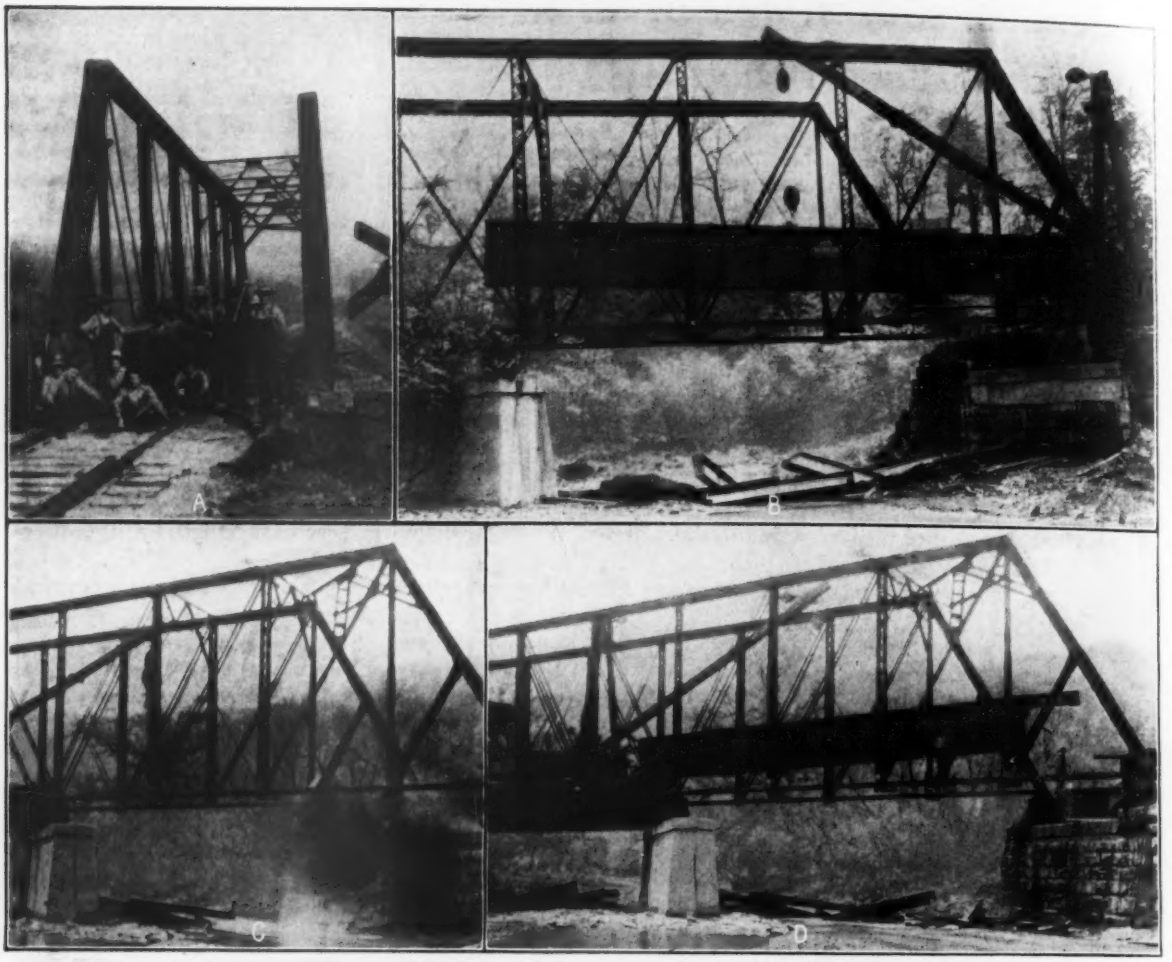


FIG. 2. GIRDER ERECTION IN RENEWAL OF BRIDGE 194A; W. & L. E. R.R.

A. One portal and two swayframes removed. B. Floor of first half of bridge in river and girders being set. C. Dropping the floor of the second half (view from side opposite that seen in B). D. Setting girders in second half. (Note new concrete intermediate pier and concrete bridgeseats on old stone abutments)

ing the girders began immediately. The stringers in the panel directly over the new pier had been burnt in two by an acetylene torch, and were blocked upon the pier at such points as would clear the new girders. The bolts in the stringers were removed first. A line was hitched to the bottom flange and pulled up until one end of the stringer cleared the lower flange of the floorbeam; then the stringer was dropped in the creek below. The bolts were then taken out of the floorbeam connections and a line hitched to its bottom flange and pulled up until it cleared the post and was dropped into the creek. In some instances the floorbeam carried the stringers in the next panel with it.

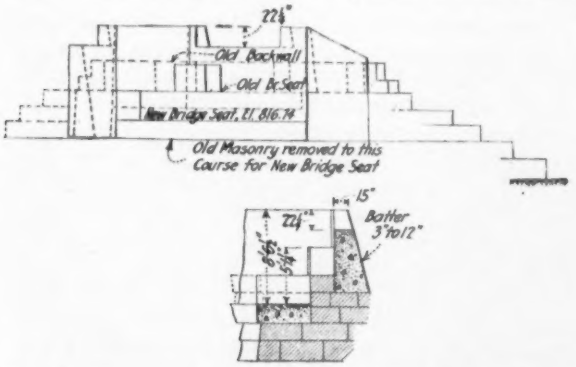


FIG. 3. TYPICAL ABUTMENT CHANGE IN REPLACEMENT OF THROUGH-TRUSS BRIDGE BY DECK-GIRDER BRIDGE; W. & L. E. R.R.

This operation continued until the stringers and floorbeams in the first half of the span were removed. This left a clear space between the old trusses, from the abutment to the middle pier, and then the new girders were picked up one at a time by the derrick-car and placed in position. The laterals, both top and bottom, and cross-frames were bolted up, and the ties and rails for the first span placed.

The derrick-car moved forward, and the erection of the second span was carried on in the same manner.

All top bracing, except one end portal and one end strut which were left to steady the ends of the trusses, was removed and two inverted gallows-frames (Fig. 4) were placed at the posts and bolted to them. By the use of the long turnbuckles, this frame was easily adjusted to its proper position. The frames supported the trusses while

the chords were cut and sections removed, which work was done after the plate-girder spans were riveted up.

Two of these bridges being on a 6° curve, the rocker

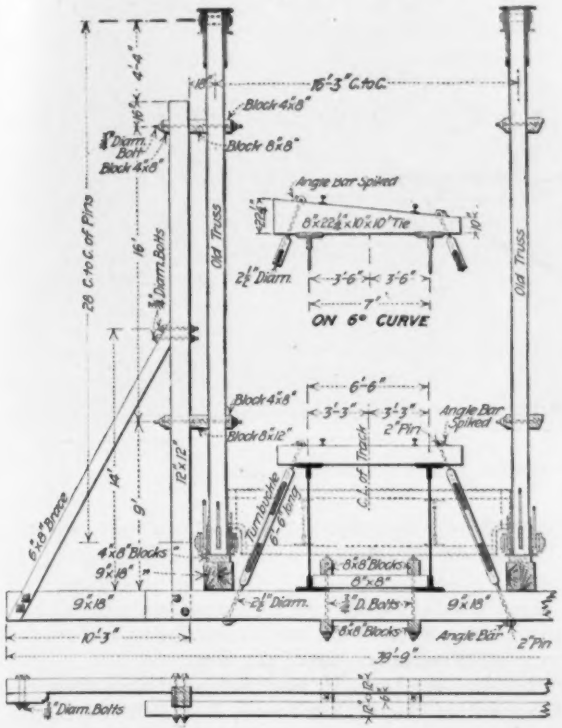


FIG. 4. POSITION OF OLD AND NEW BRIDGES AND FRAME PLACED IN DISMANTLING

plates on the bolster on one side of the derrick-car were taken off and a block bolted on the bolster on the other side, bringing the body of the car level, in order that the car might be in perfect working order.

Concreting Car-Track Intersections with a Portable Mixer

In placing the concrete foundations for car-tracks at street intersections, which work consisted of a number of small separate jobs, a light portable mixer was used, as shown in the accompanying view. This work was at Wichita, Kan. The contractor was P. F. Connolly, of El Reno, Okla., and he used a mixer outfit built by the Archer Iron Works, of Chicago. It weighed about 1770 lb., and in moving from place to place the front end of the truck was raised and hitched to a wagon.

LAYING CONCRETE AT STREET INTERSECTIONS WITH A LIGHT AND PORTABLE MIXER OUTFIT

The mixer drum is mounted on a wheeled truck and is arranged for end discharge. It has a capacity of 4½ cu.ft. of concrete. The charging end is fitted with a hopper into which the charge is dumped from wheelbarrows, an inclined runway being laid from the street to the platform on the truck. The discharge spout delivers the concrete into a chute as shown. Above the drum is a frame carrying the gasoline engine and a water tank. This tank is supplied direct from a convenient hydrant by means of a hose, as shown.

There were 200 to 250 cu.yd. of concrete at each intersection, with a thickness of 6 to 15 in. The highest record was 112 cu.yd. placed in 10 hours. The materials were wheeled by three men for distances up to 50 ft., but four men were employed for hauls of 50 to 200 ft. In addition there was the foreman, one man at the machine, one spading the concrete, and another helping in the spading or on odd jobs.

New-Style First-Aid Kit

The first-aid jar of medicaments and apparatus shown in the accompanying illustration has been devised by the National Affiliated Safety Organizations (M. W. Alexander, Secretary, West Lynn, Mass.) and is being put out at cost (about $5.50). This is being done as part of a

FIRST-AID JAR OF THE NATIONAL AFFILIATED SAFETY ORGANIZATIONS

campaign in training men in proper first-aid work; another effort is being made by the introduction of concise new first-aid rules (printed in ENGINEERING NEWS, Feb. 11, 1915).

The container is an annealed glass jar with a glass cover on which the new rules are mounted; it is thought that glass will be more easily kept clean than tin or wood, besides making the contents more easily seen. The cover is held on by spring clips and is sealed with a rubber gasket. The jar is about 6x9½ in. and weighs, filled, 12 lb.

The contents comprise a tourniquet, pair of scissors, pair of tweezers, triangular sling, roll of wire-gauze for splints, assorted safety pins, teaspoon, metal cup, paper drinking cups, medicine glass, medicine droppers, record cards, 24x36-in. flannel, roll of absorbent cotton, 10-yd. rolls of 1-, 2- and 3-in. gauze bandage, five yards of 1-in. adhesive plaster, packages of 6x36-in. sterile gauze, tubes of burn ointment (3% bicarbonate of soda in petrolatum), 2-oz. bottles of castor oil, 3% alcoholic iodine, white wine vinegar, 4% boric-acid solution and jamaica ginger. The bottles, bandages, cotton, ointment tubes and splint roll are set on end along the wall of the jar, so that they can be quickly located and easily pulled out. A metal dish keeps these materials in place and holds the other contents.

For service on trucks, etc., where the jar might be broken, a padded shipping case is provided, with a hole in the lid through which the cover handle can be grasped.

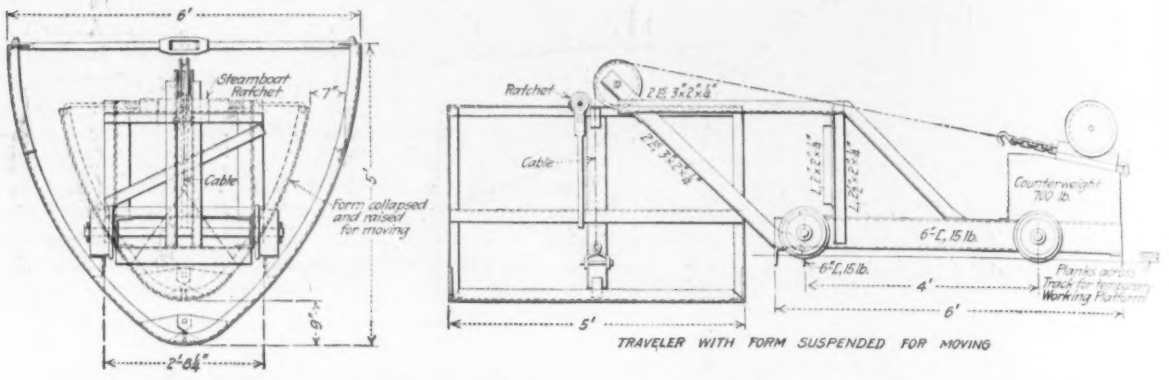
Collapsible Form for Sewers

An intercepting sewer extending from Glencoe, Ill., to the North Shore drainage canal at Wilmette is being built by the Sanitary District of Chicago to intercept the sewage now discharged into Lake Michigan by several residence towns. The main part of this is about 2¾ miles of egg-shaped concrete sewer 6x9 ft. and 6x8 ft., in cut 20 to 25 ft. deep.

This sewer was built by the use of steel forms of special design, having the bottom portion detachable. Owing to the pressure it was desirable to leave the sides of the forms in place as long as possible, but the bottom portion could be removed earlier. This portion was hinged at the bottom and had a joint on each side about 22 in. below the upper edge. This permitted the form to be collapsed and reduced to such section that it could be raised and run ahead through the forms already in place and again set up in advance.

For handling the 5-ft. lengths of forms a special traveler or derrick was used, having flanged wheels riding on angle-iron rails carried by brackets on the forms, the machine being low enough to pass under the struts and turnbuckles of the upper section of the forms, as shown. The invert form weighed about 300 lb. per ft., or 1500 lb. for each 5-ft. section, and to balance this the traveler carried at its rear end a 700-lb. concrete counterweight.

A drum on the traveler operated the hoisting cable, the end of which had a sling to be attached to the sides of the



COLLAPSIBLE STEEL FORM FOR SEWER INVERT, WITH TRAVELER FOR HANDLING IT AND RUNNING IT AHEAD THROUGH THE FORMS ALREADY IN PLACE

form. The collapsing of the form was effected by a steamboat ratchet on the traveler, having rods whose ends were hooked into the ribs of the form.

The forms and traveler were designed by the Blaw Steel Construction Co., of Pittsburgh, Penn. The contractor for the sewer was Henry J. McNichol, of Chicago.

Performance of a Small Gasoline Tractor with Caterpillar Pilot-Wheel

BY J. GARDNER BENNETT*

A small gasoline tractor is used on a Southern reclamation project to break the soft muck land, to move heavy machinery, move houses, pull stumps, and do much work with a block-and-tackle that ordinarily requires the use of a capstan or hoisting engine.

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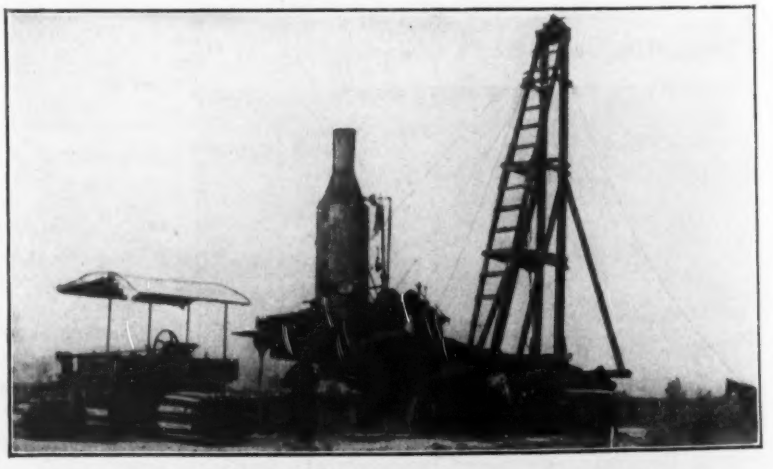
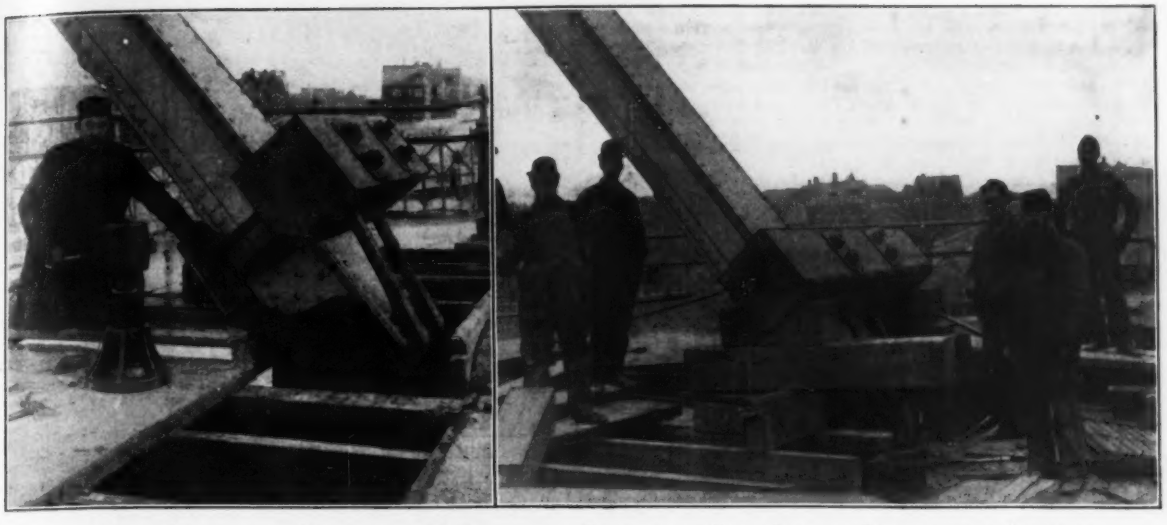


PILEDRIVER HAULED BY TRACTOR WITH CATERPILLAR PILOT



ORIGINAL RIG; JACK UNDER CORNER OF 16x16-IN. TIMBER

SUCCESSFUL RIG; JACKING-LEVER UNDER SADDLE-BLOCK

In the view the tractor is moving a piledriver loaded on a heavy machinery float. The outfit was moved complete and ready to operate. The hammer was in the leads and there was coal on the fireman's platform. The shell road was smoothed by a King drag in front of the tractor. The piledriver was moved over the 3½ mi. of country shell road in 1½ hr.

The regular work of the tractor is breaking the muck lands, which are too soft for the use of animals. For this heavy going it is geared down to a speed of 2 mi. per hr. Plows are used that will turn the soil upside down without much breaking up of the dirt. Experiments show that this makes the sod rot rapidly, and at the same time leaves a more solid layer of earth on the surface, which will shed much rain and will dry in lumps. This all helps materially to hasten the solidification of the soil so that it can be properly cultivated.

"Strait's Tractor" is manufactured by the Killen-Strait Manufacturing Co., Appleton, Wis. The price is $2500. It is driven by a 20-hp. 4-cylinder motor, and is equipped with three small caterpillar wheels which give a bearing surface of 2800 sq.in. for a total weight of 4 tons. The use of a caterpillar pilot-wheel is a successful innovation. It will not slip nor sink in while turning. This makes it turn around easily and in a shorter radius.

The cost of breaking soft muck land has been about as follows: Operator's wages for a 10-hr. day, $3; gasoline, $2; lubrication, $0.40. This amounts to a total of $5.40 for plowing five acres, or $1.08 per acre.

Hook Suspension for Lowering a Highway Bridge

A job of highway bridge lowering done 20 years ago, in which rather novel methods were used, is brought out by the article in our issue of Feb. 18, 1915, on raising a highway bridge by end-pin slings. Henry B. Seaman, New York City, describes the work as follows:

The Park Ave. Bridge over the New York, New Haven & Hartford tracks in Mt. Vernon, N. Y., of 184 ft. span, 60 ft. wide, built in 1895, was originally set 42 in. high, on blocking, to give enough clearance before the grade of the railway was lowered. Six months later the tracks were lowered to the new grade, and the bridge could then be brought down to its permanent level. The method first proposed was to use falsework, a method involving a cost of some $3500. By the method actually used the writer carried out the job at a cost of $300.

The pin could not be reached by a stirrup, on account of the flange angles of the end post. The post was therefore clamped by a 16x16-in. timber and bolts, and hooked rods were passed through the timber and hooked under the lower end of cover-plate and flange angles of the post, as seen in the left-hand view. The bottom corner of the timber was beveled off to give a bearing for jacks. However, when the jacks were applied the timber (yellow pine) split. It was replaced by an oak timber, a saddle put under the corner, as shown in the right-hand view, and a short longitudinal stick under the saddle used as a lever in applying the jack. This arrangement worked satisfactorily. The bridge was lowered in steps of 3 in. to the permanent bridgeseat.

NOTES

Cracked Hollow Columns in a Chicago Building—The hollow granite columns in the La Salle St. front of the Continental and Commercial National Bank Building, Chicago, have developed cracks. They are about 41 ft. high, and form a loggia at the street level. The load-carrying portion in each case is a heavy steel column, which continues up through the building. When this had been erected to the height of the architectural "masonry" column, rings or cylinders of red granite were lowered over it, and the space between steel and stone was packed with concrete. Each of the built-up granite columns has 11 of these granite rings, 2 ft. 11 in. high, with a diameter of 4 ft. 9 in. at the base of the column and 4 ft. 4 in. at the top. The average thickness is 8 in., but at one point this is reduced to 5 in. to clear the flange of the inclosed steel column, the rings being placed eccentrically to the steel column.

A number of the rings in several of the columns have now split or cracked, and in others incipient cracks are evident. It is supposed that cavities were left between the concrete filling and the stone, or were formed by shrinkage, and that during wet and cold weather moisture worked its way in and froze.

The fact that the original turning or finishing on the column rings was defective is considered a contributing cause

of the fractures. This condition made it necessary to work on the columns nearly all last summer; their faces had to be kept wet for the purpose of honing and polishing (which was done by a motor-driven machine moving around the column), and this checked the natural evaporation of moisture from the concrete in the interior. It is not thought that vibration in the heavy steel column could have caused the cracks. As the building is completed, the damaged rings can be replaced only by rings composed of two or more segments. The building, including this architectural column construction, was described in our issue of Nov. 13, 1913.

Benchmarks for Subway Work—Some excellent results have been obtained in leveling in New York City subway work by the use of a self-reading rod and a three-wire 20-in. dumpy level. The level-party consists of two rodmen, one instrumentman, and a recorder. The instrumentman reads all three wires, the reading being noted by the recorder. The rod is a 10-ft. one-piece rod and its length is frequently checked with a steel tape. Elevations are taken on temporary benchmarks or turning points along the route. Since construction operations will disturb points on the street in which the subway is to be built, the reference or permanent benchmarks are set in the side streets. From two to four of these benchmarks are usually set in each side street, the elevations of which are determined from the nearest turning point. No effort is made to tie the benchmarks of one side street to those of another street other than the adjustment of the turning points originally made.—P. M. Entenmann, New York Public Service Commission, in "Public Service Record."

Simplified Binding System for "Engineering News"—A novel way of binding and marking "Engineering News" for filing is used by A. W. Grosvenor, Fort Wayne, Ind. The essential part of the binding system is that a flexible cover is used in place of a stiff board cover. This appears to make the volume open flatter, but a very important feature of the arrangement is the reduced cost of binding (if done by the binder, 60c. per volume, or $1.20 for the two volumes of a year).

The parts of each issue that are not to be preserved in the bound volume are first torn off. If any pages of these sections are wanted for file they are clipped out and pasted in a scrap-book under their appropriate headings. With a little practice, tearing off the sections not wanted pulls the staples out at the same time, thus disassembling the reading pages. In this condition the 26 issues of the half year are stacked in proper order with the index on top, and are then ready for the binder.

The binding is flexible manila board; five stitches are taken in each volume and the thread then tied. The stitches are about $\frac{5}{16}$-in. from the back. Then the back is covered with glue and a strip of black cloth about an inch wider than the thickness of the volume is glued on, which secures the stitching. The volume is then put in the cutting press and the three sides trimmed smooth and square. The volume bound in this way is a book which can be handled conveniently. It opens practically flat—a valuable feature.

In placing these books on a shelf they should be laid flat, backs out. A title slip may be written on the typewriter and glued on. The ordinary sectional bookcase will hold 16 volumes.

Ready reference to specially valuable articles in bound volumes can be had by inserting paper markers in the volume at the page containing the article, the marker projecting from the top of the volume enough to take the title of the article. Different colors of markers may be used to indicate main divisions, such as dams, bridges, buildings, pavements, etc.

Rating a Planimeter—The problem of determining the proper setting for the adjustable tracer-arm of a polar planimeter had to be handled recently by S. E. Shoup, Kansas City, because the table furnished with the instrument had become illegible from damage. By measuring several known areas with eight different settings of the tracer-arm and reducing the results to reading per sq.in. of actual area it was possible to draw a curve showing the rating for any setting. This curve proved to be a hyperbola (i.e., reading multiplied by setting = constant), as it should. Computing the constant from the actual results obtained in the test, values from 21,541 to 21,567 were found, showing that the error was very small and also that the graduation of the arm was accurate. Using this fact the setting for any particular case is determined very simply from the equation

$$\text{setting} = \frac{\text{constant}}{\text{reading}}$$

which is especially convenient in working on maps of unusual scale, such as double-process prints (which often shrink as much as 5%), or lithograph maps reduced without regard to the resulting scale.

Example: Required to measure drainage area in acres on a U. S. Geological Survey map having a scale of 1 = 62,500. Then

$$1 \text{ in} = \frac{62{,}500}{12} = 5208 \text{ ft.}$$

$$1 \text{ sq in.} = \frac{6208^2}{43560} = 602.2 \text{ acres}$$

To bring this within the limits of the scale of reading divide by some figure as 5, giving 120.4, so that each vernier unit becomes equivalent to 5 acres. Then the setting will be

$$\frac{\text{constant}}{120.4}$$

or for the particular instrument in question

$$\frac{21560}{120.4} = 179.1$$

Diagram for Temperature Correction of Steel-Tape Measurements—The accompanying diagram is almost self-explanatory. It is designed to be inserted in an ordinary fieldbook to facilitate the reduction of steel-tape measurements to standard temperature. By following any oblique line to its intersection with a given temperature line, the correction in

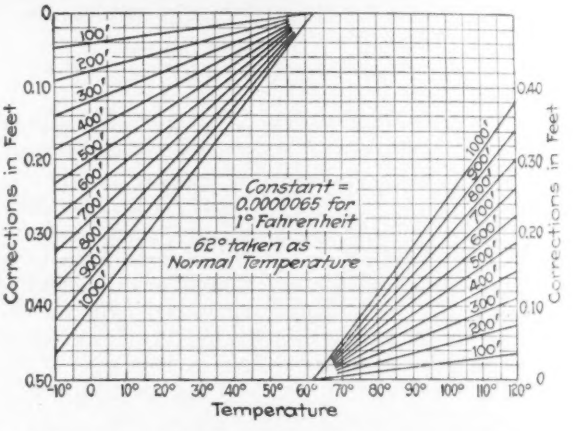


FIG. 1. FIELDBOOK DIAGRAM FOR STEEL-TAPE TEMPERATURE CORRECTIONS

hundredths of a foot for each length of tape or line is readily obtained. For example, assume that we have measured 765 ft. at a temperature of 20° F. Following the 700-ft. line to its intersection with the 20° temperature line, we read horizontally to the left a correction of 0.19 ft. Similarly we find the correction for 100 ft. to be 0.03 ft. The correction for 65 ft. being practically two-thirds of that for 100 ft., we get a total correction for the 765 ft. of 0.19 + 0.02 ft. = 0.21 ft. Therefore we must measure 765.21 ft. at 20° for a distance of 765 ft. at 62°. The diagram has been used to great advantage on center-line railway work. Much time has been saved and liability to error from field calculation has been eliminated—Harry E. Smith, Norfolk & Western Ry. Co., Portsmouth, Ohio.

Comparative Costs of Hauling Material by motor trucks and by horse teams during the past year's work in the City of St. Paul, Minn., indicate that for long hauls the motor truck is the cheaper. Specifically the figures are as follows, assuming a team to have an average speed of 3½ miles an hour and to cost $6 per day, and a motor truck to have an average speed of 11 miles an hour and a cost of $20 a day: For anything under a ½-mile haul the team is cheaper; between ½ mile and 1½ miles the cost is about equal, though slightly favoring the motor truck, and for any haul above 1½ miles the cost for the motor truck is cheaper.

Special Molding-Sand Wanted—A sand is wanted to take the place of "French sand" for fine statuary casting in bronze. French sand contains about 80% silica and 20% alumina. It is a prepared mixture of very fine sand and clay. When slightly damp and crushed in the finger it feels very much like putty. During normal times French sand sells for about $5 a barrel. The August Griffoul Bros. Co., bronze casters, 280 Chestnut St., Newark, N. J., will be glad to test and report free of charge on samples of sand sent to that address. Samples should not be less than 1 cu.ft. in bulk.

Editorials

In these columns three years ago (May 2, 1912) we took occasion to comment on the remarkable fact that when the present reform administration in Philadelphia came into office, it found *not a single engineer* in the Bureau of Highways. We are happy to be able to state now, on the authority of William H. Connell, Chief of the Bureau, that the personnel of the highway department includes 181 engineers out of a total of 271 salaried employees.

Incidentally, Mr. Connell also reports that the officials of the highway department are much overworked. The engineering and overhead administration charges of his bureau amount to only 4.8% of the bureau's expenditures, notwithstanding the enormous amount of supervisory work necessary to the contract method of street cleaning and snow removal, as well as a vast amount of routine clerical work.

The folly of short-term contracts for the disposal of garbage and other municipal refuse has been urged more than once in these columns. It is gratifying to know that New York City will probably soon be able to let a relatively long-term contract for the disposition of the garbage, ashes and rubbish of the whole city (see our news columns), in general accordance with a plan worked out in 1912 by a committee of the Board of Estimate. If the expectations of the Board of Estimate of that and the present time, and also, we understand, of J. T. Fetherston, Commissioner of Street Cleaning, are realized, the new scheme will put the city in possession of complete refuse-disposal plants at the close of the proposed 15-year contract. Under the five-year (maximum allowed) contracts that have heretofore prevailed in New York, and the even more absurd one-year contracts in Philadelphia, high prices, continual risk of capital and danger of poor service have been inevitable.

Distributing Rewards for the Panama Canal Work

Congress did an excellent and creditable thing when just previous to its adjournment last week it passed the bill tendering its thanks to Colonel Goethals and his associate officers on the Isthmian Canal Commission, providing for their advancement in rank and providing also that 21 other army officers who have served three years or more on the Isthmus during the construction should be advanced one grade in rank upon retirement.

But if Congress had taken pains to bestow honor and rewards where honor and rewards are justly due for the Panama Canal work, it might well have extended its thanks, at least, to some of the able civilian engineers, who rendered service at Panama as faithful and efficient as that rendered by the army officers. Col. Goethals, himself, has been recently quoted in a magazine article, written by Secretary Bishop of the Canal Commission, as saying that a number of the civilians were as deserving of credit and reward as any of the army men, and mentioning particularly for his conspicuous ability, S. B. Williamson, who was for several years in charge of the entire work of the Pacific division.

And if Congress really set out to award credit for the Panama Canal achievement where credit is most largely due, it would not stop with the engineers who have carried on the work of construction, but would go back to the earlier years when the great problems in connection with the location and planning of the canal had to be solved. Engineers, at least, should know that to the late Alfred Noble more than any other one man, the nation owes it that we did not make the mistake of starting a canal in the morasses of Nicaragua, or the other mistake of trying to build a ditch at sea level all the way across the Panama Isthmus. And of course others share this credit with Mr. Noble: the late Gen. Wm. L. Ludlow, who served with Noble on the first Nicaragua Canal Commission; Frederic P. Stearns, who served with Noble on the International Engineering Commission of 1905 and whose design for a Gatun dam saved the day for the lock canal project; Abbot and Randolph and Ripley, who joined Noble and Stearns in the famous minority report that won the support of President Roosevelt and Secretary Taft, notwithstanding the weight of professional opinion on the other side. Nor should credit be omitted for the heroic work done by the leaders at Panama in the early days when the Isthmus was being cleaned up and an organization was being created and everything had to be done and there was nothing to do it with.

Philadelphia Water-Works Problems

For two-score years or more the successive administrative heads of the Philadelphia water-works have operated under a heavy handicap. They have often if not always been compelled to see the surplus revenue of the works go for the benefit of other branches of the city service when that revenue was needed for extensions and improvements, and sometimes for ordinary repairs or renewals essential to the integrity of the works. They have also been compelled to see useless consumption and criminal waste go on year after year, while their hands were tied and, in at least one case, a mouth was shut from all efforts to prevent it. These and other deplorable conditions postponed filtration and typhoid reduction for years and greatly increased the capacity and construction cost of the purification works.

The operating costs and difficulties are now greater than they need be as an inheritance of past and present evils entirely beyond the control of the executive heads of the water-works. Nor is this all. Various parts of the works, upon which important sections of the city are dependent for their supply, are liable to be put out of commission at any time because funds are not provided by the appropriating authorities to repair, renew or improve weak elements of the works. Happily, great improvements have been made and economies effected during

the past few years, but financial and other reforms are needed before the Philadelphia water-works can be put on a thoroughly safe and economical basis.

One of the greatest needs at Philadelphia is general enlightenment and moral awakening as to the evils of water waste, with all its train of needless expense for pumping and filtration, reduced pressure, constant demands for costly enlargements of the system and unjust distribution of the cost of the water service. Assuming the population estimates to be correct, the daily per capita water consumption did fall five gallons in 1914, but it averaged 178 gal. per capita for the year, so there is still room for improvement. Pitometer surveys and house-to-house inspection have helped, but with less than 10% of the consumers metered, waste is bound to continue.

Protecting Wooden Buildings from Dry Rot

The so called slow-burning system of factory construction in which wood framing is used has come into very extended use, largely through the efforts of the Factory Mutual Fire Insurance Companies of New England. Special interest attaches therefore to a report made by F. J. Hoxie and just published by these companies which deals with the serious injury a large number of these structures have suffered by dry rot during the past few years. It is as if an epidemic of a disease attacking these buildings had swept over the country. The analogy is close because the decay of wood is well known to be due to the growth of living organisms which destroy its cells just as a large proportion of diseases attacking man and animals are now known to be due to the attack of living organisms.

While previous bulletins issued by these companies have dealt with this danger to wooden-frame buildings, the present publication, which forms a volume of over 100 pages, carries the matter much farther and contains information enabling an engineer to guard against the danger of decay in building a new wooden frame structure or to successfully treat an old factory which has become infected with dry rot. Copies of this publication can be obtained by engineers interested by addressing the Inspection Department of the Associated Factory Mutual Fire Insurance Companies, 31 Milk St., Boston.

Formerly the chief reliance for the prevention of dry rot was upon careful selection of timber in purchasing to secure species of wood supposed to be immune from attack. It is apparently now considered the safer plan to rely on some antiseptic treatment of the timber prior to its use in a new building. In locations where wood is kept constantly damp without being wet enough to actually prevent decay and where added inflammability is not an objection, the use of creosoted timber appears to be the safest plan. With nearly all the timber used in wooden factory construction, however, the inflammability of creosoted lumber is a fatal objection; and the antiseptic treatment recommended is to soak the timber for a week in a 1% solution of corrosive sublimate dissolved in water, a treatment which is stated to cost about $3 per M. ft. b.m. This is the old and well known kyanizing process.

A most difficult problem is presented where the timber in an existing factory becomes affected with dry rot. Keen vigilance is required to discover this before serious damage occurs. The treatment which appears to have the best chances of success to stop dry rot when once started in a factory building is to raise the temperature inside by means of the heating system to about 115° F. This temperature maintained for a day or two appears to kill the organisms producing dry rot.

This pamphlet appears at an opportune time, for the opening of the Panama Canal has made available to the entire eastern United States a new source of supply of first-class lumber, in any size desired, at a moderate cost. This new lumber supply will doubtless have an influence in reviving the use of slow-burning wooden construction for factory and warehouse buildings in the East. It is well for every engineer to understand therefore the danger of decay which at present attends the use of such wooden construction and the means necessary for avoiding this danger in case this type of construction is adopted.

Smoothing a Railway Subgrade to Insure Good Drainage

The cross-section drawing of a railway track always shows the subgrade neatly smoothed and crowned so as to shed water, with a layer of ballast resting on the smooth surface. The rain which falls on the track is supposed to percolate through the open ballast to the subgrade and then flow off to the right and left by reason of the crown which is given to the subgrade.

This is the theory of railway track construction; but what engineer actually engaged in building a railway actually smooths the top of the subgrade to a neat crown before laying the ties? The usual and ordinary course is to lay the ties on the subgrade just as it is left by the grading gang, and proceed to lay the rails, after which construction trains and very likely traffic trains will run over the track for weeks before ballasting is completed and the track is surfaced.

The final result of these various processes is that instead of the ballast lying on top of a neatly smoothed and well-crowned earth bank, adapted to shed water like a duck's back, the actual condition is that if one excavated a cross-section of the track it would be hard to tell where the ballast left off and the subgrade began. If the earth of the embankment is porous, the chances are that much of the water which falls on the track will work down into the bank.

It is an interesting speculation as to how a railway track would behave if it were really constructed according to theory, so that the subgrade could shed water. In the January "Bulletin of the American Railway Engineering Association," there is a description of a piece of railway track actually built in this way.

A subcommittee of Committee No. 1 on Roadway was appointed to report on means for the prevention or cure of water pockets in the roadbed. After describing various practices in construction which cause water pockets to form in a railway embankment, the committee quotes a report by Messrs. H. T. Porter, Chief Engineer, and F. R. Layng, Engineer of Track of the Bessemer & Lake Erie R.R., as to the method adopted in laying a stretch of additional track between Keepville and Albion, Penn., 2½ miles in length. We quote as follows from the report:

In 1910 it was decided to double-track this stretch. The material was excavated by steam shovel, hauled on flat cars, plowed off with a side plow and spread with a Jordan

spreader. The material consisted of shale and clay of such a character that it was unfavorable to good drainage. With the idea of consolidating this material and forming a crust at subgrade so that the ballast would not punch holes into the subgrade, a 10-ton Kelly-Springfield roller was used to roll the subgrade behind the spreader. If the roller developed soft spots, they were replowed and rolled again with the result that before track was laid we had a hard crust formed at the top of the grade. The rolling cost $125 per mile.

The track was then laid and ballasted with screened slag and has not been given a resurfacing since, and on this entire stretch there is not a single indication of the formation of a water pocket. This new track is the north-bound main track; and during nine months of the year carries 24 to 38 freight trains and three regular passenger trains daily. As a matter of fact it has hardly been necessary to set a jack under this track, and no lining, except in a few spots, has been done. It is really remarkable the way the track has stood up and it is our belief that the rolling of the subgrade is in a large measure responsible for the results obtained.

Every engineer in charge of either railway or highway work is supposed to write it down as the first article of his creed that drainage, first, last and all the time, is the greatest essential to success. In railway track maintenance it is accepted as a necessity that a large amount of labor must be expended every year to keep track in reasonably good surface. In the light of the above quotation it is interesting to raise the question as to how much of this expense might be saved if a railway subgrade were really built so that it would drain off the water according to theory; that is to say, if it were given a reasonably hard, smooth surface, reasonably impervious to water and sufficiently crowned so that the rain percolating through the ballast would run off to either side instead of soaking the embankment? Is it not possible that the expenditure of a hundred dollars or so per mile in such treatment of the subgrade preparatory to laying track might save an equal or greater amount annually in reduced cost of track maintenance?

Why Did This Axle Break?

In our issue of Oct. 1 last, we illustrated and described a bridge accident on the Baltimore & Ohio R.R. near Woodlyn, Penn., on Sept. 19, in which the end-post of a through-truss bridge was struck by a derailed car, causing the collapse of the structure under the train. The derailment of the train was found to have been caused by the breakage of a truck axle under the locomotive tender.

In the report upon this accident, just issued by the Interstate Commerce Commission, a statement is given as to the circumstances under which this breakage occurred and the research made to ascertain the probable cause. We particularly commend this report to the careful study of any of our readers who like to tackle tough engineering problems. The report is, moreover, a most interesting and instructive showing of the remarkable behavior of which materials under stress are sometimes capable.

In the first place, the axle did not break because it was too small to carry its load. It measured 6 in. in diameter in the journal and 7⅝ in. in diameter in the wheel-fit. Breakage occurred just inside the wheel-fit near the outer face of the wheel hub. The total weight of the tender when fully loaded, under which this axle was used, was 165,000 lb., an average load of 20,625 lb. per wheel, or deducting the weight of the wheel itself, 20,000 lb. on each journal.

James E. Howard, the Interstate Commerce Commission's engineer-physicist, has computed the stresses in the axle, assuming this load of 20,000 lb. to be applied at the middle of the length of the journal. Under these conditions, the maximum fiber stress at the inner end of the journal would be only 5186 lb. per sq.in., and at the place where the journal broke, less than 4000 lb. per sq.in. The tensile strength of the metal of the journal, determined by several test specimens cut from it, was about 75,000 lb. per sq.in. on the surface of the axle, and about 71,000 lb. at the center. There was no evidence of anything of the nature of brittleness. The test specimen showed 29% elongation. Furthermore, axles of this size are required to stand a drop test of a 1640-lb. weight falling from a height of 52 ft. and the test axle has to stand seven such blows.

The axle broke by progressive fracture, a not uncommon form of railway axle breakage. When breakage of this sort occurs, a fine crack opens on the surface of the axle when under tension, and is closed as the wheel turns and the stress at the crack changes from tension to compression. This crack gradually works inward, the section of solid metal growing smaller and smaller until fracture finally occurs. When this B. & O. tender axle finally broke, there was only about 3 in. in diameter left unbroken, or a section about a quarter the area of full section of the axle. How long this progressive fracture had been in progress there is no means of knowing. It could not have been discovered by inspection since it was inside the wheel-fit. There is reason to believe, however, that such progressive axle fractures often develop quite slowly.

It seems to be an inevitable conclusion from this axle fracture and similar axle fractures which are on record that a car axle is subject to instantaneous stresses from impact amounting to several times the static load. In the present case, if we assume the elastic limit of the metal in the axle to have been one-half the ultimate strength, or over 35,000 lb., then there must have been a maximum fiber stress imposed on the axle at some time *over nine times* that due to the maximum static load. Such excessive stresses doubtless occur very rarely; perhaps, for example, when a wheel passes over a very bad crossing. Under such repeated stresses, even though they occur at long intervals, it is probable that the metal finally begins to separate and a fine crack forms at the surface. The effective strength of the axle is, of course, reduced in proportion to the depth of the crack, and the deeper the crack extends the greater the amount of breakage effected at each passage over a rough crossing or bad frog or rail joint, if we assume that this is what does the mischief.

As to the reason why the crack in the axle started at the particular place it did, the only thing which Mr. Howard could find to account for this was a peculiar circumferential scoring on the surface of the axle which, it is conjectured, may have been due to the action of the wheel itself when forced onto the axle by the hydraulic press with the face of the wheel not quite square with the line of the axle. We particularly commend this report to the committee now engaged in investigating the stresses in railway track. If the above analysis is correct and service conditions set up maximum fiber stresses in railway axles which at certain times reach eight times the static stress due to the load carried, the conclusion seems inevitable that abnormal stresses equally great may at times occur on the surface of the rail, so that a normal wheel load of 20,000 lb. may at times reach as much as 160,000 lb. If this is a fact, it is small wonder that rails break occasionally; the wonder is that they do not break oftener.

Letters to the Editor

What Is Wrong with the Engineering Profession?

Sir—Within the past few years there has been noticeable a general dissatisfaction among engineers with their position in the sun, to adopt a present-day trite expression. Attendant upon such dissatisfaction is naturally the question of inadequate remuneration.

I believe one reason why engineering is not on a par with the other professions is because only a small proportion of engineers are actually professional men. The great body of engineers, so called, are on a par with the artisans, and there is small distinction between the ordinary draftsman or field man and the mason and mechanic. This is forcibly brought home by the fact that the wages paid to each are practically the same.

Engineering is unquestionably the greatest of all professions, for it is the one purely constructive profession and hence of greatest benefit to society. It is apparent, then, that were there only engineers in the correct professional sense, they would be leaders in every branch of the body politic. Yet because of this heterogeneous collection of various types of engineers its distinctive professional bearing is submerged and consequent upon this is the loss of the world's leadership.

Requiring state licenses for engineers is a futile remedy. The public is commencing to realize that we cannot create or change economic laws by act of legislature. What we ought to do is to impress upon those about to study engineering the qualifications requisite for its proper pursuit, so that they may ascertain to what extent they are capable of acquiring these qualifications.

That the professional schools can make engineers is absurd. That they do turn out thousands with what we may term an engineering finish is true.

If you will, let us establish industrial schools for teaching the hand-maiden arts in connection with professional engineering, but let us not confound these schools with the real engineering schools. It is in attempting to combine the two without distinguishing their relative importance that the present-day conditions of engineering have arisen.

G. P. C. E.

New York, Feb. 27, 1915.

[Mark Twain, in "Captain Stormfield's Visit to Heaven," described the high honor paid in heaven on the arrival of the greatest poet who ever lived on earth. He proved to be a poor shoemaker from a village in the Tennessee mountains, who had never actually written any poetry, but who had the ability to have written finer stanzas than Shakespeare or Goethe or Homer, if only he had had the opportunity.

Admittedly, as our correspondent says, most engineers are chiefly engaged in the routine work of measuring and computing, and a few only are required to do the work of original planning and the executive work of directing. But it is altogether likely that not a few of these routine workers have the inherent ability to do successfully what our correspondent terms the higher professional tasks, provided they had the opportunity to prove their ability. It is doubtless the feeling that some state system of examinations would enable men to demonstrate their ability that leads many engineers to favor them. The personal qualifications determining high professional success, however, are not determinable by any system of examinations.—EDITOR.]

Experiments on Wind Pressure

Sir—Apropos of Mr. Fleming's interesting articles in ENGINEERING NEWS on stresses due to wind loads, may I call the attention of your readers to G. Eiffel's book, "La Resistance de L'Air: Examen des formules et des expériences." It is a review of the work of 70 or 80 well known experimenters. The book gives many of the data on which each authority has based his approximate formula, together with descriptions of apparatus and discussion of the advantages and the disadvantages of the different types. Discrepancies in the formulas are due to neglect of factors that are important. Among the topics discussed are the effects on the intensity of wind pressure of size and shape of plane surfaces, angle of incidence, curvature of the surface, and atmospheric density; and the distribution of pressure over a plane surface. At the end Eiffel gives a few of his own experiments. The book is fairly comprehensive and a well condensed statement of information necessary for one who is to form more than a random judgment on wind loads.

A later book, "La Resistance de L'Air et Aviation," of which there is now an English edition, gives the results of Eiffel's own experiments and is of interest more especially to designers of aëroplanes.

ERNEST L. ROBINSON.

New York, Mar. 1, 1915.

The Architects' License Law in Illinois

Sir—The article in your issue of Feb. 25 by an Illinois Engineer, upon "The Effect of Architects' License Laws upon Engineers," would have been worthy of more serious thought had the author correctly stated the facts, which, as to Illinois at least, he could have readily secured by examining the records of the State Board of Examiners of Architects. These records show conclusively that more applicants for architects' licenses fail on the strictly engineering problems than upon draftsmanship. It is further a matter of record that no competent structural engineer has ever failed to pass the test of the written examinations conducted by this Board.

A careful inquiry into the motives prompting the sponsors of the proposed license law for engineers in Illinois will disclose some interesting facts:

1. The financial sponsors and principal backers of the proposed law are not professional engineers, but representatives of contracting firms who make a practice of furnishing so called "free plans" for buildings to clients who may be induced to purchase their special building products. Recently a number of this fraternity have been arrested and fined in the Illinois courts for practicing architecture without a license, and there are many other similar cases not disposed of by the courts.

These firms object to having their work done under the supervision of competent architects, and naturally are most hearty supporters of the proposed license law for engineers, which, if it becomes a law, will give them the legal right to practice architecture without the necessity of passing a technical examination.

2. There is a second group of men who favor the law, who are now employed as draftsmen in offices making a specialty of detailing structural steel, etc. These men believe that if they can secure the right to contract to furnish professional architectural service, they will be able to better their own financial condition. They believe that it would be hopeless for them to attempt to pass the examination conducted by the State Board of Examiners of Architects, and hence as a body are for the proposed law.

3. A third class wish to have the profession of structural engineering licensed in order that they may become members of established architectural firms.

4. There is yet a fourth class of engineers who believe that engineers should have the legal right to design strictly engineering structures, and this right is conceded by the architectural profession. Perhaps, unfortunately, the defining of a building, by the Architects' License Law, is so broad as to cover all classes of building structures, and the architects are in favor of having their law amended so as to give to the structural engineer the legal right to design and supervise the construction of strictly engineering buildings. They define such a building as one not involving housing conditions. This would give the licensed structural engineer the right to handle all work in connection with warehouses, power houses, buildings in connection with water-works plants, coal tipples and similar buildings or structures.

However, the proposed bill will probably encounter serious opposition from many sources. Its sponsors will be called upon to show to the Legislature that there is a public need for such a law. They must show that buildings designed by the architects of Illinois are unsafe and unsanitary, and that the state must as a police measure enact their proposed bill as a matter of public safety.

Should the proposed bill become a law it will repeal absolutely the existing Architects' License Law, and the profession of architecture will no longer legally exist in Illinois. Every architect, if he wishes to continue in practice, must take out a structural engineer's license, and practice as a structural engineer, and having in mind the fact that the enactment of the Architects' License Law in 1897 legally qualified several hundred incompetent men to practice, what may be expected to follow the passage of the proposed engineers' bill?

There are today at least 800 licensed architects in Illinois, four-fifths of whom are earning but a mere livelihood. The enactment of the proposed law will at once at least double the number of those who can legally practice architecture, or as it will then be, architecture under the legal guise of structural engineering. Who can foresee the result of thus doubling the competition in a state where there does not exist sufficient work for those at present practicing the profession of designing buildings? It will require 20 years to weed out the incompetent engineers who would qualify under the existing law, just as it has required 18 years to weed out the incompetent architects who qualified in 1897.

These facts should be most seriously considered by the engineers who favor the bill, and particularly by those engineers who have a standing as professional men. There are today in the entire State of Illinois less than 40 men who can properly be classified as professional structural engineers.

Perhaps the best solution of the entire problem will be to let those who wish to practice architecture qualify as architects, and thus secure the legal protection of the law that has stood the test of time and been pronounced good law by the Supreme Court of the State of Illinois.

WESTERN ENGINEER.

Chicago, Mar. 1, 1915.

[It may be of some interest to note in connection with the above report of the Illinois situation that the architects' registration act which has been introduced in the New York Legislature at the present session contains nothing relating to the construction of buildings. It simply requires that any person desiring to call himself an architect must pass an examination and obtain a certificate. An engineer or carpenter or plumber or anyone else is free to design and construct buildings so long as they do not assume the title of architect.—EDITOR.]

NOTES AND QUERIES

A consulting engineer of long experience informs us that the majority of young engineers who apply to him for positions do not inclose stamps for replies. He believes that it would be for the interest of engineers seeking positions to inclose stamps, and states that where this is not done he does not acknowledge the inquiry. Although we agree that as a rule a stamp might well be sent with such inquiries, they might readily be worded so no reply is either requested or required, in case no vacancy exists. This would be more considerate than to inclose a stamped and addressed envelop, thus making most recipients feel that they ought to reply, when all they can say is that they have no position to offer. If a specific or implied request for a reply is made, then both courtesy and self-interest demand the inclosure of a stamp.

How Broadway Subway Construction Looked to the engineers of 1866 is given in an interesting interview of Alfred W. Craven, Chief Engineer of the Croton Aqueduct, uncle of Alfred Craven, the present Chief Engineer of the Public Service Commission, which is building the new subways for the City of New York. Mr. Craven, senior, is quoted by the "American Journal of Mining," Apr. 7, 1866, as remarking "that the proposed underground railway beneath Broadway would cut the main artery of the water-supply system; that during its construction the water must pass through side pipes, which would not supply the wants of the inhabitants; that no water would be available for extinguishing fires; that factories must be stopped, and the damages accruing as the result would be enormous, say not less $100,000,000. He said that any tunnel excavation by blasting, even at a depth of 10 or 15 ft. under the water pipes, would injure the joints of the pipes by concussion." If Mr. Craven, who died in 1879, had lived to the present day, he would have seen how his own nephew was building the Broadway underground railway not only without injury to the precious water pipes, but without the least interference with street traffic.

Shrinkage Stresses and the Columns of the Edison Buildings

By F. R. McMillan*

In view of the wide interest that has been aroused by the recent fire in the Edison buildings, the accompanying curves may be of interest to the profession. These curves, taken from a forthcoming bulletin of the University of Minnesota on "Shrinkage and Time Effects in Reinforced Concrete," show the effect of time on concrete deformations, which, it will be seen, may have had much to do with the failure of those columns without lateral reinforcement.

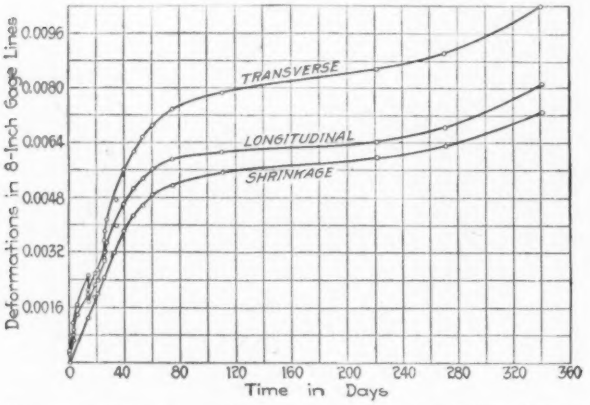


FIG. 1. CONCRETE DEFORMATIONS OF 6x8-FT. REINFORCED-CONCRETE SLAB UNDER CONTINUED LOAD

The writer believes with Mr. Sewell, as stated in his letter in ENGINEERING NEWS, Jan. 7, 1915, p. 39, that the concrete may have spalled somewhat before the heat was sufficient to expand the steel appreciably. But he does not concur in the statements that the buckling of the steel was an effect and not a cause. For it will be seen from the data here presented and the discussion that follows that the column verticals must have been under a stress approaching the elastic limit at the time the fire broke out, and that but a very slight expansion, if any, was required for these to kick out, with the destructive effects noted. Indeed, with the cracks along the line of the steel, developed by even a slighter heat than Mr. Sewell suggests, the high stress alone would account for the kicking out of the already weakened concrete.

If this explanation is accepted, it would seem that the lesson to be learned is even more important than simply the necessity for efficient lateral reinforcement.

That such high stresses may exist will be seen from a consideration of the curves in Figs. 1 and 2. These represent the results of measurements made on a 3-in. slab 6x8 ft. in plan and supported on four sides. The photograph in Fig. 3 gives a general view showing the supports, the slab and the loading material. This slab was designed for a live load of 100 lb. per sq.ft., on the ordinary assumptions of a rectangular panel reinforced both ways, with 75% of the load assumed to go to the short span. It was cured in a warm room for 80 days under a covering of sand that was kept continually moist. Tests of 8x16-in. cylinders cured under the same conditions showed a compressive strength of 1825 lb. per sq.in. and a modulus of elasticity of 2,500,000 at the age of 72 days. Transverse specimens similarly cured showed a modulus of rupture of 380 lb. per sq.in. at 71 days.

The slab was cleaned off and dried out for a few days before the measurements and loading operations were begun. These latter consisted in the application of a load of 50 lb. per sq.ft., an increase to 100 at three days, the whole removed after eleven days and reapplied twelve days later. From this time it has been continuously in place for more than ten months. These load changes can be traced on the curves by the sharp breaks to be seen during this period.

The two upper curves of Fig. 1 represent the deformations in the top fiber of the concrete at the center of the slab, measured by Berry extensometers over 8-in. gage lines established in both transverse and longitudinal directions. The lower curve represents the shrinkage in the concrete as obtained from extensometer measurements on the top of the slab at the edges where there was no load deformation.

The significance of these total deformation curves lies in the large increase that occurs with time, and in the fact that the shrinkage alone does not account for this increase. By noting the sharp breaks in the curve on the 14th and 26th days, showing the effect of release and re-application of the load, it will be seen that the transverse deformation resulting from these load changes is only 0.0006 in. per 8-in. length, corresponding to a concrete stress of about 200 lb. per sq.in. The total transverse deformation at the end of 340 days is 0.0104 in. per 8-in. length, or 17 times that produced by the application of the load alone, an increase of 1600% in about one year. Subtracting from the total the load effect of 0.0006 and the shrinkage of 0.0072 there still remains a deformation of 0.0026 inches per 8-in. length which is due to the yielding of the concrete with time.

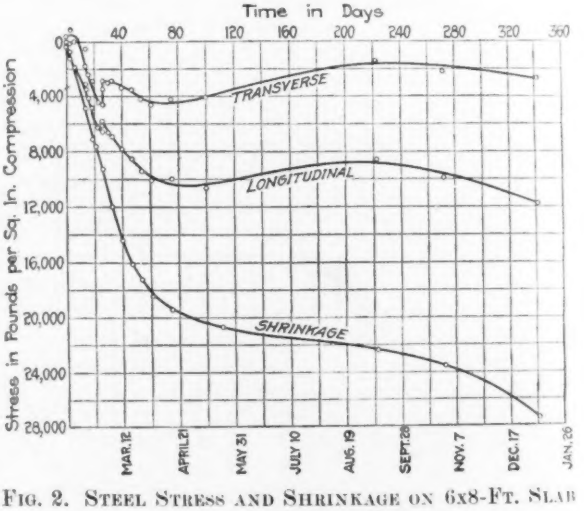


FIG. 2. STEEL STRESS AND SHRINKAGE ON 6x8-FT. SLAB UNDER CONTINUED LOAD

In some other tests which will form a part of the publication referred to, it was found that this last element was nearly equal to the other two combined. That this was not true of this slab is accounted for by the

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low unit stress in the concrete, for although the time yielding increases somewhat with an increase in unit stress (as can be seen from a comparison of the transverse and longitudinal curves), even with the same multiple as exists here, a unit stress of 600 lb. per sq.in. would have increased the time yield to three times 0.0026, or 0.0078 in. per 8-in. length. Hence it will be seen that these large deformations due to shrinkage and time yielding would produce in the vertical steel of a concrete column abnormally high compression stresses. Supposing a condition of even such low unit stress as exists in this slab the total deformation represents a steel stress of 39,000 lb. per sq.in. which might easily occur in a column of similar materials. While it may be a matter of pure speculation it does seem probable that conditions nearly as severe as this may have existed in the columns of the Edison buildings.

FIG. 3. REINFORCED-CONCRETE SLAB UNDER LOAD FOR OVER A YEAR

The probability of such stresses existing in compression members will be still more apparent from a study of the curves in Fig. 2. The two upper curves of this figure represent the total stresses existing in the tension rods of this slab, obtained from extensometer measurements made directly on the rods. It will be noted that except for a few days after the first application of the load these stresses are compressions throughout the entire period of the test. The lower curve of this figure is the same shrinkage curve as shown on Fig. 1, obtained from measurements at the top of the slab, but for convenience of comparison plotted, in Fig. 2, to a scale of steel stresses. It will be seen that this shrinkage at the end of a year is equivalent to a total stress of 28,000 lb. per sq.in.

The very remarkable fact that the principal tensile reinforcement showed a compression of 4000 lb. per sq.in. after the load had been in place three months and 2500 lb. at the end of eleven months, and the secondary reinforcement a compression of 12,000 lb. at the end of eleven months, seems to clearly indicate that dangerously high compressive steel stresses may be expected in members where load and shrinkage are acting in the same direction. While the writer believes with most of those commenting on the failure of the Edison columns that proper lateral ties would have saved many of these columns, he does not believe that the problem of the reinforced column will be solved by this conclusion.

Hydrated Lime in Road Concrete

The State Roads Commission of Maryland, under the supervision of H. G. Shirley, Chief Engineer, is making some interesting experiments on the effect of about 10% of hydrated lime mixed with the portland cement used for concrete highway pavements. The first experiment was made in the summer of 1913 on a state road in Wicomico County. The proportions of hydrated lime to cement, by weight, varied from 10% to 11%.

The most noticeable effect of the hydrated lime on the wet mixture was increased plasticity. The ease with which the wet concrete slipped from the chute showed this. With a plain 1:2:4 mixture without the lime, there was a tendency for the concrete to stick to the sides of the chute.

In reporting on the condition of the road in August, 1914, W. F. Childs, Jr., Resident Engineer, stated that the sections in which the lime was used were apparently more homogeneous and dense. This condition was so discernible that he could readily pick out the sections in which the lime was used by observing the difference in the finish of the road surface. There was an apparent lack of *laitance* and a uniform wearing of the surface. There were no signs of checks, or of transverse or longitudinal cracks. On adjacent sections, where lime was not used, there were transverse cracks. Apparently the hydrated lime had a tendency to reduce the effect of temperature changes, and thereby to prevent cracking.

In a report on a road built at Accident in the fall of 1914, L. T. Downey, Resident Engineer, stated that it was found by experiment that with a medium wet mixture small cracks appeared in the pavement, but in a wetter mixture this was not noticeable. He attributed these cracks to the stone absorbing moisture. The addition of 10% by weight of hydrated lime to the portland cement seemed to give density to the mixture; the men on the strike board observed that it was harder to pull the board when lime was used. The lime gave the mixture a richer appearance and it apparently retarded the setting somewhat. By Dec. 8, 1914, cracks other than joints seemed to be fewer on sections where the lime was used than on other sections of the road.

Similar experiments have been made by the U. S. Office of Public Roads and by the U. S. Bureau of Standards upon the effect of hydrated lime in cement mortars. A note in ENGINEERING NEWS of Nov. 26, 1914, p. 1086, gives the conclusions of Henry S. Spackman, of Philadelphia, on the effect of hydrated lime on volume change and strength of portland-cement mortars and concrete, and an editorial in the same issue comments on the application of hydrated lime in concrete road work.

An Injunction to Restrain the Operation of the Sand and Gravel Plant of the Wellesley Gravel Co., Boston, Mass., has been refused and a suit for damages dismissed by Justice Walt, of the Massachusetts Superior Court. The plaintiff was an adjoining property owner, who contended that the plant constituted a nuisance. The justice held that the district in which the plant was located had not yet reached a stage in which its use for residential purposes could be considered exclusive, that the gravel there was of a particularly good quality, and that the development of the gravel deposit could be reasonably anticipated. As approved methods were used for stripping, excavating, sorting and handling the product, and as no unusual or unreasonable machinery was used, there was no cause for action, except that the plaintiff, who was a woman, was a person of peculiarly nervous constitution.

The New Knox Four-Wheel Tractor Truck

A motor vehicle capable of carrying a 10-ton load with 60% of the weight carried on large steel-tired wheels has just been put on the market by the Knox Motors Co., of Springfield, Mass. For several years this company has been manufacturing a three-wheel tractor in which the front end of an ordinary heavy truck was carried on a platform over the rear driving wheels of the tractor. This machine has now been redesigned with two wheels in front instead of a single wheel and with a number of novel features. The illustration in Fig. 1 shows one of the tractors just furnished to the Borden Condensed Milk Co., equipped with one of that company's heavy trucks as a trailer, with a capacity of 10½ tons of paying load. It will be understood, however, that the trailer vehicle may be of any type desired. The front end of the trailer vehicle rests on a turntable over the rear wheels of the tractor.

The new tractor, fully equipped but without a trailer, imposes a load on the front pair of tires of 3750 lb. and on the rear tires of 4700 lb. When the trailer is attached there is no increase of the load on the front tires, but with an ordinary truck about 40% of the weight of the trailer with its load is carried by the driving wheels of the tractor and 60% by the rear wheels. If the trailer carries a paying load of 20,000 lb. and its weight empty is [illegible] lb., the total weight on the driving wheels of the tractor would be about 14,400 lb., and about the same weight would be carried by the rear wheels of the trailer. The wheel-base of the tractor itself is 108½ in.

The front wheels have 36x4-in. solid tires, and the driving wheels have 38x6-in. solid double tires. The width of the face of each section of the driving-wheel tires is about 4½ in., or 18 in. for the two wheels. Thus the total weight imposed on the road surface by the driving-wheel tires of the tractor when carrying a fully loaded trailer is about 800 lb. per in. of width. Notwithstanding the length of the whole vehicle when the trailer is attached, it can turn in very crowded quarters, as the front wheels are so designed that they can be skewed to a sharp angle, and the center plate on which the front end of the trailer rests is so designed that the tractor can swing to a sharp angle with the trailer and not foul anything.

The ingenious arrangement of springs by which the tractor machinery and the driver are carried easily and smoothly over rough roads and left entirely free from the

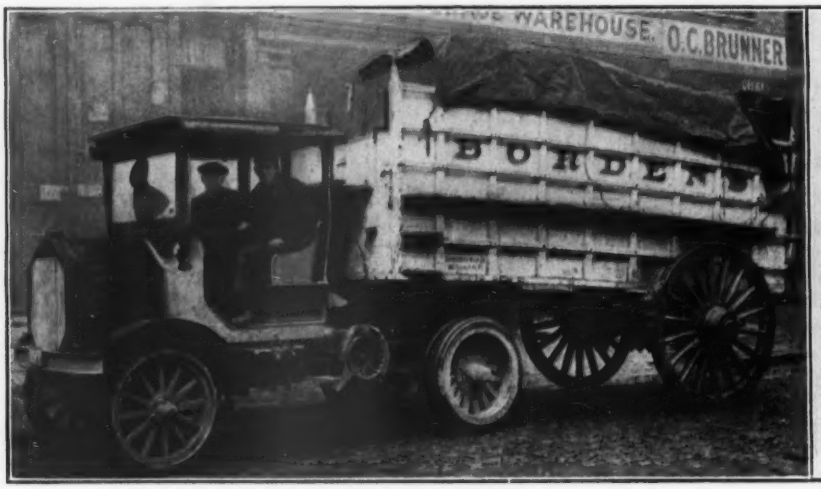


Fig. 1. The New Knox Four-Wheel Tractor Drawing a 10-Ton Trailer Truck

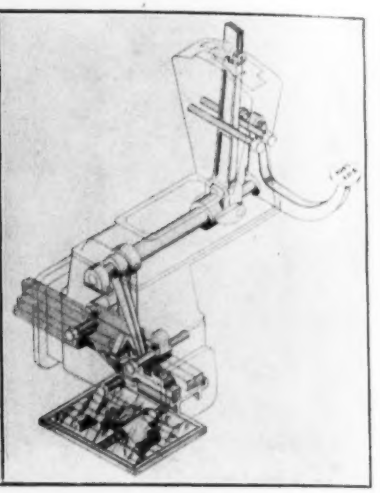


Fig. 2. Interlocking Differential Lock Mechanism

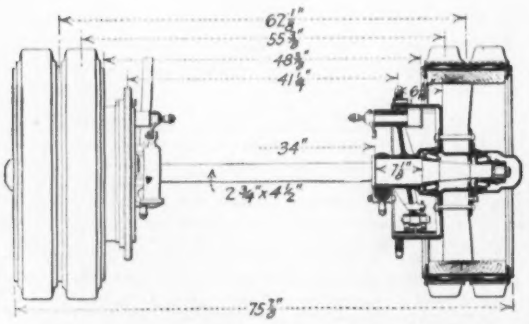


Fig. 3. Section through Rear Axle, Showing Emergency-Brake Drums and Driving Wheels

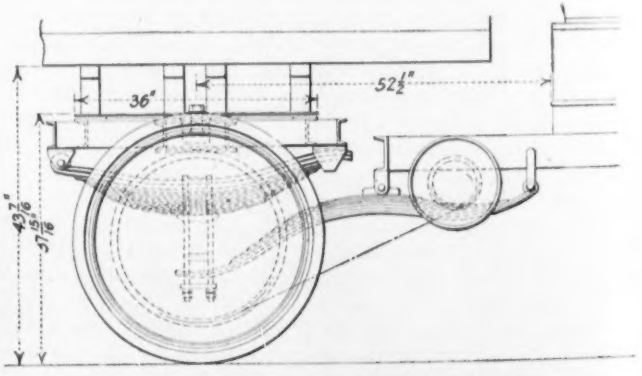


Fig. 4. Spring Support of Center Plate for Front End of Trailer and of Rear of Tractor Chassis

jar of the heavy load carried on the trailer and the driving wheels is shown in Fig. 4. As there seen, the load on the center plate which supports the front end of the trailer is carried by very stiff and heavy springs to the driving-wheel axle, while flexible cantilever springs 48 in. long, entirely independent of the heavy springs above referred to, support the rear of the tractor chassis and have their rear ends resting in slideways under the rear axle. Thus the rear axle is isolated from the tractor chassis, and while it is maintained in line by strut rods it is free to move up and down, equally or unequally as to either of its wheels, without motion of the chassis. This construction should not only add materially to the comfort of the driver, but should be of advantage in relieving the engine and propelling machinery from the jar and vibration inevitable when a very heavy load is carried on a freight truck, besides relieving the tractor chassis from twisting stresses.

A very interesting feature in the design of the propelling machinery is the interlocking differential lock. As every driver of a motor car knows, the differential gear through which the rear axle is driven, while absolutely essential to enable the vehicle to turn corners, is a very serious drawback to the effective traction of the machine on slippery or muddy roads. If either driving wheel slips, the entire power is transmitted through the slipping wheel, while the other driving wheel remains stationary just at the time when its effective traction is most needed.

The differential lock is a mechanism by which the driver, by pressing down a lever in the floor of the cab, can lock the differential gears so that the two driving wheels are compelled to turn together as if the rear axle were one rigid piece. If, however, this lock were thrown into the gears with the engine running and one driving wheel slipping, perhaps at high speed, breakage of the gears would be inevitable. In order to prevent this, the mechanism by which the differential gear is locked is connected with sliding bars which move the transmission gears and throw the transmission into neutral position before the differential lock can engage. Of course, when the transmission gear is thrown to neutral, the slipping rear driver in contact with the road instantly stops. The mechanism by which this result is effected is quite similar in its general design to the familiar mechanical interlocking apparatus for railway switches and signals. After the driver has locked the differential, he can then set the speed-change gear to any position he desires.

A feature of truck design which has given a good deal of trouble with trucks operated in hilly country is the braking system. As every engineer knows, a brake is merely a mechanism for converting the inertia of a moving vehicle into heat. On an ordinary touring car weighing 1500 to 4000 lb. the ordinary type of brake, consisting of a contracting band on the exterior of a brake drum on the rear axle with an expanding band on the inner surface of the same drum, works satisfactorily. The amount of heat generated by the brake is not great enough to cause overheating of the parts, and on long and steep hills careful drivers generally use the engine to assist in retarding the car. When a heavily loaded truck is descending a long hill, however, the number of foot-pounds which must be converted into heat between the top of the hill and the bottom becomes so great that, unless sufficient surface is given the brakes and sufficient provision made for the dissipation of the heat, difficulty is apt to be experienced.

The service brake on the new Knox tractor is designed, not on the lines of the ordinary pleasure-car brakes, but on those of railway-car braking practice. A cast-steel drum, 14 in. in diameter and 4-in. face, is secured to each end of the jackshaft, as seen in Fig. 1. A foot lever in the driver's cab enables him to bring a pair of cast-iron brake shoes in contact with the faces of this drum. The driver can automatically lock this brake lever in any position he desires. The inner surface of the drum has a large number of projecting ribs for radiating the heat developed. The cast-iron brake shoes are as easily removable and about as cheap to renew as the brake shoes on a railway car. As the jackshaft turns in fixed bearings and is not variable in position with reference to the chassis, as is the wheel of a railway car, the brake shoes can have a very close adjustment, so that very small motion of the foot lever is required to apply or release these service brakes.

In addition to this effective service brake, an emergency brake, operated by hydraulic power, is applied to the interior of two heavy drums 20 in. in diameter and 6½-in. face, secured to the rear axle, the driving sprocket forming part of the same drum. A section of the hydraulic-brake mechanism is shown in the accompanying cuts. The hydraulic pressure is transmitted by a flexible pipe from the pressure pump in the driver's cab to the brake-operating cylinder on the rear axle. Thus the rear axle may move as it pleases with reference to the chassis of the tractor without affecting in any way the adjustment of the brake.

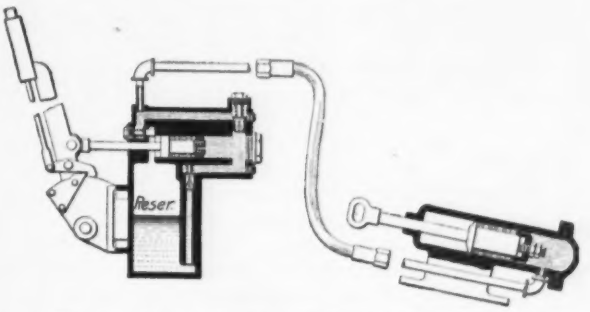


FIG. 5. FORCE-PUMP AND BRAKE CYLINDER OF HYDRAULIC BRAKE

The hydraulic pump applying the brakes is operated by a hand lever convenient to the driver's seat. Three or four quick strokes of the pump are sufficient to bring the expanding brake bands in contact with the drums on the driving axle. The ratio of the hydraulic pump plunger and of the brake-band setting plunger is 10 to 1, enabling the driver to exert an enormous braking force on the driving axle. This brake pressure is maintained until the handle of the hydraulic pump is moved forward to the end of its travel, when a valve is released, allowing the liquid to flow back to the reservoir, when the springs withdraw the brake shoes from contact.

Another interesting departure from ordinary motor-truck design is the omission of the governor generally applied to motor trucks to limit the speed at which the vehicle may be run. Instead of applying a separate governor, the designers of the motor used on the tractor have adopted such proportions that at a speed of 1000 r.p.m. the horsepower of the motor begins to rapidly fall off, in whatever gear the transmission is running.

The gear ratios of the transmission are such that with the motor running at 1000 r.p.m. and the transmission in high gear, the tractor will run at 9.4 mi. per hr. In intermediate gear the speed of the tractor is 3.9 mi. per hr. In low gear the speed of the tractor is 1.6 mi. per hr. It will be noted in Fig. 1 that there is a large speed reduction between the jackshaft and the rear driving axle. When this type of tractor is built for use with fire-department vehicles, larger sprockets are used on the jackshaft, and with some other alterations in the gearing a maximum speed of 33 mi. per hr. in high gear can be obtained.

Another interesting and important mechanical feature is the use of oil under pressure for lubrication. Lubricating oil is forced to the main bearings by a small gear pump which delivers the oil under a constant pressure of

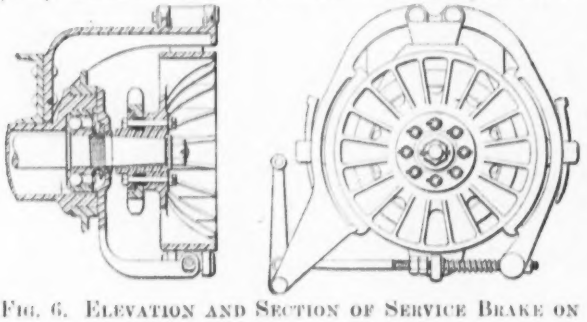


FIG. 6. ELEVATION AND SECTION OF SERVICE BRAKE ON JACKSHAFT

30 lb. per sq.in. through holes drilled into the center of the main bearings. This is the system of lubrication now in use on the bearings of large marine naval engines, where the service is most severe. Experience has shown that under these conditions a constant film of oil under pressure is maintained between the shaft and its bearings, and wear is practically eliminated.

The truck is equipped with an electric lighting and starting system. There is little doubt that this will be considered an economic necessity in future motor-truck design. If hand cranking must be used to start the motor, drivers will inevitably keep the engine running idle whenever the truck is standing rather than undergo the exertion of cranking it; this idle running involves a constant waste of fuel and keeps the engine hot. With an electric starter the driver stops the engine whenever the truck stops, knowing that he can start it by pressing a button.

The motor of the tractor has four 5x5½-in. cylinders, cast in pairs and having the valves placed in the heads, which are bolted to the cylinders. The gasoline supply is contained in a 25-gal. reservoir and is fed by a vacuum system to the carburetor. Four gallons additional is carried as an automatic reserve supply.

Finally, it may be noted that the engine has been specially designed with a view to work in the wet and muddy regions which the contractor's motor truck often has to encounter. The carburetor, magneto, generator and starting motor are all placed high upon the engine, at least 31 in. above the ground level, so that in case of necessity the machine can be run through water of a considerable depth without being put out of commission.

The Department of Public Works, of Beverley, Mass., formed last year by a consolidation of the street, sewer and water departments, has been enlarged by combining with it the engineering department.

Philadelphia Water-Works in 1914*

A total of 105 billion gallons of water was supplied by the Philadelphia water-works in 1914, or an average of 173 gal. per capita per day for an estimated population of 1,655,000. The per capita consumption in 1913 was 178 gal. Both pitometer work and house-to-house inspection were continued during the year.

and as the installation of meters is voluntary "meters

Less than 10 per cent. of the consumers are metered, are not installed unless the consumer expects to save money, and such consumers are not the wasteful users of water." The meter rate is only 4c. per 1000 gal., and that for water which is both pumped and filtered. It is suggested that the rate be changed to 12c. per 1000 gal. for the first 500,000 gal., 8c. for the second like amount, and 4c. for all consumption over 1,000,000 gal.

Service-pipe leaks cannot be controlled because services are put in and repaired by property owners. If the Water Bureau locates a service-pipe leak by excavating to a street main it is compelled to refill the hole and notify the owner of the service. The latter engages a plumber, who has to go to the City Hall for a permit, then re-excavate to the leak, repair it, report to the City Hall for inspection, and, after inspection, refill the hole. An ordinance authorizing the Water Bureau to make these repairs as soon as service leaks were discovered was before the City Council in January, 1915.

The total revenue of the Water Bureau for 1914 was $5,242,081. The total expenditures (not including capital charges) were $2,380,749, but of this $553,995 went for new construction, thus leaving operation and maintenance expenses of $1,826,754.

The coal used for pumping has decreased in amount from 201,168 tons in 1912 to 179,736 tons in 1912, and in cost from $616,601 to $509,145. The cost of unloading and reloading coal in the outside storage yard at the Lardner's Point pumping station was reduced 75% (40 to 10c. per ton) by "a better use of the coal-handling apparatus."

Breaks continued during the year in one of the Hartwell Ave. water mains. A break in this main "about Christmas is the sixty-first that has occurred on this line since it was put in service, about twenty-one years ago." An additional line is recommended.

A number of important large mains still remain supported on wood trestles in different sections of the city. One of these, a 48-in. pipe, "is the only carrier of filtered water over a stretch of about one mile" on Eva St., "and the supply of Germantown and Chestnut Hill is dependent upon the maintained integrity of this pipe."

Progress was made in the installation of a new accounting system during the year. This will be furthered by the functional classification of the annual appropriations for 1915.

Another advance in record keeping is the casting of the filter-operation statistics for 1914 in accordance with the standard form recommended by a committee of the New England Water-Works Association.

Finally, the typhoid death rate for Philadelphia was about 8 per 100,000 for 1914, compared with 13 for 1913.

*Notes based on an advance copy of the 1914 annual report of C. E. Davis, Chief of the Bureau of Water, Philadelphia, Penn.

Water Terminals on the Mississippi River

A conference to consider the question of terminal facilities at river ports in the Mississippi Valley was held at St. Louis last summer (ENGINEERING NEWS, June 11, 1914). A second conference was held at the Planters' Hotel, St. Louis, Mo., Feb. 18 and 19, 1915, with an attendance of 110 delegates from cities and towns along the Mississippi, Missouri, Ohio and Illinois rivers.

The papers presented were of three classes, relating to the question in general, to the work done or proposed at various river towns, and to the engineering aspect of providing facilities for the accommodation of vessels and the handling of freight. Mr. Lazarus, president of the City Council of St. Louis, stated that the city proposes to build extensive water terminals, and to acquire a river-front railway line when its franchise expires in 1915. Mr. Hooke, Director of Public Utilities, and Mr. Walbridge, President of the City Plan Commission, described the proposed terminals more in detail. Mr. Moore, New Orleans, advocated municipal ownership of water-front facilities. Other speakers dealt with the municipal wharves and warehouses at Kansas City and Minneapolis. The Missouri River boat line, now operating between St. Louis and Kansas City, was described by A. W. Mackie (Kansas City).

A brief paper by E. E. R. Tratman, of the editorial staff of ENGINEERING NEWS, explained the high cost of terminal handling as compared with the cost of transportation, and the consequent necessity of efficient and economical means of handling freight at terminals. Another paper by H. McL. Harding (New York) dealt with freight-handling machinery, and opposed the use of the sloping river bank landing where traffic is considerable. A paper by L. K. Sherman, of the Illinois Rivers and Lakes Commission, dealt with freight handling at river ports. Mr. Perry (Quincy, Ill.) pointed out that any large development of water traffic requires boats of modern type operating on regular schedules, and also the issue of bills of lading to all parts of the country instead of merely from port to port. R. C. Wilson, consulting engineer for the New Orleans Association of Commerce, suggested the use in river service of large steel barges which could lie alongside ocean steamers to receive and deliver freight directly.

A resolution was adopted recommending that in any state, city or town located on waterways, which has not power to create, maintain and operate water-front terminal facilities, an earnest effort should be made to obtain the necessary power or authority.

It was voted to establish a permanent organization. Adolph O. Eberhart, ex-Governor of Minnesota, is Chairman of the River Terminals Conference, and James E. Smith, St. Louis, Mo., is Secretary.

The Use of Patented Pavements by Cities

Many laws, city charters and city ordinances have been enacted forbidding the use of patented materials or machines in municipal work. These laws have had their origin partly in some notable cases in the past where patented devices have been used at exorbitant cost to the taxpayers as a result of dishonest collusion with city officials, and partly in cases where suits for very heavy damages have been brought against cities because of some use of a patented device without consent of the owner of the patent. Such laws, however, have proved impracticable of complete enforcement. The progress of the acts is largely reflected by the issue of patents, and to wholly prevent a city from using any patented device until the patent had expired, 17 years from the date of its issue, would place the city hopelessly behind the times.

An interesting review of the status of the laws covering the use of patented paving materials by cities was recently given in a lecture delivered before the highway engineering class of Columbia University, by George C. Warren, President of Warren Brothers Co., Boston, Mass. Mr. Warren is, of course, an interested party, but his wide experience in litigation over the use of patent paving should make his summary authoritative.

Cases involving the legality of the adoption of patented pavement by municipalities have been decided within the past 20 years by the highest courts in the states of New York, New Jersey, Ohio, South Carolina, Oregon, Missouri, Maryland, Louisiana, Kentucky, Michigan, Kansas, Iowa, Indiana, Idaho, Oklahoma, Pennsylvania, Tennessee, Massachusetts, California, Montana, Washington, Wisconsin and Illinois.

With the exception of the last two states, the final decision in all of the states is to the general effect that, where the owner of the patent voluntarily surrenders his exclusive rights and agrees to allow any contractor to use the patent, on the payment of a reasonable price, all the competition which the law requires is provided. Under such regulations, patented pavements may be laid and contracted for by municipalities; and any state law which prohibits the adoption of a patented pavement by municipalities is unconstitutional, because it attempts to prevent the exercise of the federal patent franchise, which is based on the United States Constitution.

Of the two states in which decisions of the final courts have been adverse to patented pavements, the Wisconsin legislature promptly amended its law so that patented pavements may be used; and Illinois stands alone as the only state in which there is practically a prohibition of the use of patented materials in municipal assessment work.

The courts of most of the states above referred to have declared that the competition required by the state laws is provided if the owner of the patent files with the municipality a binding agreement under which, at a certain price, he will sell the patented portion of the pavement, which patented portion is generally confined to the wearing surface, to any responsible bidder; so that all such bidders may compete with the patentee or his agents for the construction of the whole pavement.

Rock Phosphate has recently been discovered by J. T. Pardee, of the U. S. Geological Survey, at three points in western Montana—6 mi. north of Garrison, at Philipsburg, and near Elliston. The last named field has recently been examined by the Survey. A total of over 85,000,000 tons of phosphate rock is estimated. None of the Western deposits have yet been developed, owing to the recency of their discovery and to the lack of markets sufficiently near to justify mining and reduction. But there is a growing tendency to use fertilizers where the land is farmed intensively, especially in the Middle West. The Western phosphate deposits are favorably situated to meet a demand from this section of the country and will doubtless be utilized in the future.

News of the Engineering World

New Main for Jersey City Water-Supply

Plans and specifications are being prepared for a 12-mile main of 72-in. cast-iron pipe to supplement the conduits which supply Jersey City with water from the Boonton reservoir. The Boonton reservoir and appurtenances were finally taken over by Jersey City after several years of litigation in 1911. The features of the water-works are a 7,362,000,000-gal. intake reservoir with 122½ sq.mi. of tributary drainage area, and a single 76-in. steel conduit, except for two 6.85-ft. brick-lined tunnels, one through Hook and the other through Watchung mountain. We are informed that the specifications for the new main will be ready in about four weeks and that the Board of Street and Water Commissioners, of which Charles A. Van Keuren is Chief Engineer, has the authority to issue bonds to cover the cost of construction.

Refuse Disposal, New York City

A charter amendment authorizing New York City to let a long-term contract, not to exceed 15 years, on a profit-sharing basis, for the final disposition of garbage, ashes, rubbish and street sweeping has passed the legislature and will probably receive the approval of the Mayor and Governor. Under the terms of the bill the city would furnish land and fixed structures, if the contractor proposed to locate the disposal works on city land; or the contractor might furnish land, fixed structures and equipment. In either case, all the refusal-disposal property of the contractor would revert to the city at the end of the contract.

It is believed that a single contract for all classes of refuse, for a considerable period, would warrant the necessary investment and that it would result in economy and efficiency. At present, refusal-disposal contracts are limited to five years and there are a number of separate contracts. Under one of these contracts, the New York Disposal Corporation receives all garbage delivered by the city from the boroughs of Manhattan, The Bronx and Brooklyn. The contractor transports the garbage to Barren Island and there treats it in reduction works. The contract price is $62,500 a year for 1914, $87,500 for 1915, and $112,500 for 1916, with the privilege on the part of the city of renewal for 1918 and 1919 at the price for 1916. Ashes and rubbish in Manhattan and The Bronx are disposed of by Dailey & Ivins at 23.9c. per cartload of 1½ cu.yd. of ashes and 7½ cu.yd. of rubbish. In Brooklyn the Brooklyn Ash Removal Co. is paid 63c. for ashes and 10c. for rubbish, for cartloads of the same size. The city is paid $726 per week for the privilege of picking and trimming the Manhattan ash and rubbish scows. In December, 1914, all four of these contractors were in litigation with the city or were defending suits brought by citizens on the allegation of nuisance.

The estimated cost of proper plant for the final disposition of all classes of wastes from the whole city is about $9,000,000. Of this, it is assumed that, under the charter amendment, the city would provide fixed structures at a cost of $2,500,000 and the contractor would provide equipment costing $6,500,000. Refuse disposal in 1914 cost New York City about $1,400,000. The foregoing rates are based on information supplied to this journal by J. T. Fetherston, Commissioner of Street Cleaning, Municipal Building, New York City.

Another State Power Development

The operation of the hydro-electric power development at the Wachusett Dam of the Metropolitan Water Board, of Boston, Mass., has been so satisfactory that the Board has recently decided to install a similar plant at Southborough in order to utilize the fall of water flowing from Sudbury reservoir into the Weston aqueduct. Plans for the work have been prepared, and the cost is estimated by Dexter Brackett, Chief Engineer of the Board, to be about $80,000. It is expected that construction can be pushed and current delivered by October, 1915. (For notes on the Wachusett dam plant, see ENGINEERING NEWS, Feb. 11, 1912, p. 294; Aug. 14, 1913, p. 297; Jan. 28, 1915, p. 169.)

Engineering Work on the Pennsylvania Railroad

New construction work on the Pennsylvania Railroad during 1914 was of large amount in the aggregate, according to a summary in the company's annual report, notwithstanding the stringent financial conditions. The aggregate expenditure for construction and equipment on the company's owned and leased lines during the year was nearly $14,500,000.

The most interesting announcement in the report is that the company is considering plans for the future electrification of its main line across the Allegheny Mountains from Altoona, the foot of the eastern slope, to Conemaugh on the western slope "by which it is believed large operating economies can be effected and the heavy passenger and freight train movements facilitated." The distance between Altoona and Conemaugh is about 35 miles. If this project is carried out, it will be by far the heaviest traffic in the world to be moved by electric traction.

In the suburban zone around Philadelphia, electrification of the main line from Broad St. Station west to Paoli, 20 miles, is almost completed and is expected to be put in operation for suburban passenger service about June 1. If financial conditions permit, the work of electrification will be extended during 1915 to the Chestnut Hill branch and on the main line from Philadelphia to New York as far as North Philadelphia. This would change from steam to electric traction about 60 suburban trains per day.

The serious interruption to traffic by destruction of overhead wires during sleet storms has caused the company to undertake the placing of its telephone and tele-

graph wires underground. This has been done during the past year on the section from Broad St. Station west to Paoli, 20 miles, and from Jersey City to Rahway, N. J., about the same distance. During the past year the last link in the automatic block-signal system on the main line between New York and Pittsburgh was completed and put in operation.

Among the important bridge construction of the year was the completion of the five-track reinforced-concrete and stone arch bridge over the Schuylkill River at Girard Ave., Philadelphia. The superstructure is being erected of a double-track steel bridge over the Allegheny River at Freeport. The Schuylkill River bridge at Phoenixville is being rebuilt, and a double-track steel bridge is being erected over the Delaware River south of Trenton. This bridge is part of the double-track relief line for the New York division which will extend from a freight yard at Morrisville, Penn., to Colonia, N. J., about 40 miles, connecting there with the six-track system.

The great bridge over the East River which is being constructed by the New York Connecting R.R. Co., has its foundations and masonry completed to the track level and the 1000-ft. steel arch over the river is being erected. The viaduct approaches on Long Island and on Ward's and Randall's Islands are substantially completed. Plans have been completed for a new line to eliminate grade crossings in South Philadelphia, the work being done jointly by the Pennsylvania R.R. Co., the Baltimore & Ohio R.R. Co., and the city of Philadelphia.

The Imperial Irrigation District

Progress is being made in taking over the canal system of the California Development Co. A contract to that end has been made between the district and the Southern Pacific, the principal creditor of the company named, and it is hoped that title will be acquired within three or four months. Beyond this, the efforts of the district for the present year will probably be confined to the protection of the Imperial Valley against possible overflows of the Colorado River.

The Imperial Irrigation District was authorized by a popular vote of four to one on July 12, 1911, and was organized on July 25, 1911. It embraces 523,600 acres of land, of which about 315,000 acres are now under irrigation. Eventually, it is expected that between 600,000 and 700,000 acres in California and upward of 500,000 in Lower California will be irrigated. On Aug. 24, 1914, the district voted $3,500,000 of bonds, $3,000,000 to acquire the property of the California Development Co., or other suitable canals for the delivery of water to the Imperial Valley, and $500,000 for emergency work. On Nov. 3, 1914, the people of California voted for a constitutional amendment which permits an irrigation district to acquire the stock of foreign corporations in order to gain control of water systems partly within and partly outside of the United States.

C. R. Rockwood is General Manager and Chief Engineer and Walter O. Hamilton is President of the Imperial Valley Irrigation District, with offices at El Centro, Calif. Mr. Rockwood was a promoter of the California Development Co. at its organization in 1896 and was subsequently its chief engineer. We are indebted to him and to Ray S. Carberry, Superintendent of Imperial Water Co. No. 1, for most of the information here given.

An Investigation of Patents on Concrete Construction

On Mar. 1 the United States Senate passed a resolution directing the Senate Committee on Patents to investigate the patents issued to Daniel B. Luten, of Indianapolis, Ind., and to report upon their legality as soon as possible. Mr. Luten's patents cover various forms of concrete construction, mainly related to bridge work, and have been before the courts in a number of infringement suits. The resolution noted was introduced in the Senate on Jan. 8 by Senator Bristow of Kansas and was approved by the Committee on Patents before its passage. Senator Ollie James of Kentucky is Chairman of the Committee. The resolution applies only to the Senate Committee and does not require the approval of the House or the President.

New Award of the Burrard Inlet Bridge

Early in 1914 a design made by Sir John Wolfe Barry, Lyster & Partners, of London, Eng., was accepted for a long and heavy bridge across the Second Narrows of Burrard Inlet, connecting Vancouver and North Vancouver, B. C. The accepted design, for a bridge to cost $2,500,000, included the longest swing-span in existence, 581½ ft. between end bearings. (See ENGINEERING NEWS, Feb. 19, 1914, p. 432.) In August, 1914, this design was rejected as too expensive and bids asked for a cheaper design. In response to this request, three designs were submitted: by the Dominion Bridge Co., associated with Armstrong-Morrison & Co., of Vancouver, $1,916,000; by the Canadian Bridge Co., $1,846,000; and by C. A. P. Turner, associated with the Western Foundation Co. of Vancouver, $1,744,831. On these designs Ralph Modjeski, of Chicago, was asked to report. This report recommended that none of the bids should be accepted but that the bidders be allowed to revise their designs to meet certain requirements prescribed by Mr. Modjeski. However, the company supervising the bridge has just accepted C. A. P. Turner's design and has awarded the contract to Mr. Turner and his associate to erect the bridge in accordance with that design, as corrected to meet Mr. Modjeski's suggestions, for the bid price noted. The carrying out of the contract is contingent upon the raising of additional funds from the city of Vancouver and from the provincial government.

A U. S. Office of Public Roads and Rural Engineering

The annual appropriation bill for the Department of Agriculture carried through some important changes in the organization of the Department's engineering bureaus. The bill, as passed Mar. 4, provides for an Office of Public Roads and Rural Engineering.

The new law provides that there shall be one director at a salary of $4500 per annum, who shall have charge of all scientific and technical work. The total appropriation is $573,660. No part of this appropriation is to be used for the purchase or rent of roadmaking machinery, except such as may be necessary for field experimental work. The appropriation for road work proper is $282,420. For investigating and reporting upon the utiliza-

tion of water in farm irrigation, different kinds of power and appliances, the development of equipment for farm irrigation, etc., there is an appropriation of $106,400. For investigating and reporting upon farm drainage and drainage of swamp lands for agricultural purposes, conducting experiments in farm drainage, etc., there is an appropriation of $96,280. For investigating farm water supply and drainage disposal, the construction of farm buildings and other rural engineering problems involving mechanical principles, there is an appropriation of $12,805. These changes, of course, do not go into effect until the end of the present fiscal year, June 30.

Another Slide at Culebra Cut, Panama Canal, on Mar. 3, tied up traffic for at least 24 hours.

Irrigation Work on Federal reclamation projects was provided for by an appropriation of $14,000,000 at the session of Congress just closed. In addition, provision was made for nearly $1,000,000 worth of irrigation work on Indian reservations, and $120,000 was appropriated for investigations in connection with agricultural developments on irrigation projects.

Water Storage Behind the Arrowrock Dam on the Boise Project of the United States Reclamation Service, near Boise, Idaho, was begun on Feb. 25, 1915. On the same date we published an illustrated statement of recent progress on the dam. It is expected that the dam, which will be 350 ft. high, will be completed by Jan. 1, 1916, two years ahead of the original estimate. The Boise Project will ultimately reclaim by irrigation, 243,000 acres of land, at an estimated cost of nearly $14,000,000.

To Protect the Imperial Valley against injury by the overflow of the Colorado River, Congress appropriated $100,000 before adjournment on Mar. 4. The money is to be spent under the direction of the Secretary of the Interior, but not until the Imperial Irrigation District shall have paid an equal amount into the federal treasury for the same purpose. On Mar. 8, Secretary Lane was informed that the $100,000 had been raised. He directed Gen. W. L. Marshall, Consulting Engineer to the Interior Department, to leave on Mar. 9 to take charge of the river-control work, which will consist of several miles of revetment along the Colorado River and raising the Volcano Lake Levee.

Newark Municipal Exhibition—An exhibit of municipal activities was held in the corridors of the city hall of Newark, N. J., Mar. 1-7. The most interesting of the exhibits was a collection of city plans of both American and foreign cities, prepared in 1913 by the American City Bureau, at the direction of the Board of Estimate and Apportionment of the City of New York. The exhibits of the Newark Water Department included a section of an old iron fire-plug connection, recently dug up in Broad St.; some sections of lead service pipe entwined in the roots of trees and an old riveted iron service pipe lined with cement. Pipe-cleaning apparatus and other modern water-works equipment were also on exhibition.

A New Building for the Interior Department, to be built at 18th and F St., Washington, was authorized by Congress at the session just closed; $1,500,000 of the appropriation is available this year. The new building will house all the bureaus of the Interior Department except the Patent Office, the Pension Bureau and the Bureau of Education. The need of a permanent fireproof headquarters to house the valuable records of the Geological Survey, the Reclamation Service, the Bureau of Mines and the General Land Office has long been urged by engineers. Besides this provision, the sum of $500,000 was appropriated to build new laboratories for the Bureau of Mines at Pittsburgh and $35,000 for the further research of Dr. Walter Rittman in connection with petroleum and natural gas.

The New York Alien Labor Law, recently upheld as constitutional by the New York Court of Appeals, has been materially modified by the legislature, so that the law now reads that "preference shall be given citizens over aliens" (in work on public contracts). "Aliens may be employed where citizens are not available." The bill also validates contracts on the New York subway work and others invalidated by past employment of alien labor under the Court of Appeals decision. The repeal bill was passed by the Senate on Mar. 8 in response to urgent appeals from contractors on the New York subway work, the Merchants Association of New York City and other organizations, and against the opposition of the labor unions. The Assembly passed the bill on Mar. 9. Meanwhile the U. S. Supreme Court has issued an injunction suspending the operation of the alien labor law and the invalidation of contracts affected by it until the court can hear and decide upon the merits of the case.

Improvements to the Water-Works of Knoxville, Tenn., have been recommended by a committee of the Chamber of Commerce, appointed by request of the City Commissioners. The committee advises that the Tennessee River be continued as the source of supply; that a 15,000,000-gal. pump be installed at an estimated cost of $60,000 to $85,000; that $75,000 be spent for new mains, $80,000 to meter the remaining 34% of the services, $16,000 for hydrants, $7000 for valves, and that "a skillful sanitary engineer be immediately employed and placed in charge of the pumping and purification." Other recommendations are that legislative authority be sought for the appointment of three water commissioners, and for submitting to popular vote a bond issue of $500,000 for improvements beyond those already mentioned (evidently for a new pumping station, filter plant and reservoir). In case the $500,000 is not made available, then it is recommended that the old Warren mechanical filters be replaced by filters of modern design and some other changes made. J. A. Switzer was chairman of the committee that made the report.

Reduction in New York Telephone Rates—The New York Telephone Co. (Bell System) has offered to the New York Public Service Commission of the Second District (which by special authority has statewide jurisdiction over telephone service) a zone system of rates for New York City, with considerable reductions in present cost of service. The reductions spring from (1) an increase in maximum number of calls on measured service, (2) reduction in contract price, and (3) reduced tolls between boroughs. The total annual reduction in revenue is estimated to be some $2,700,000. It is expected that the offer will be accepted (although some details yet remain to be adjusted), for the new plan allows a return of only some 8% on the value of the company's property within the city as fixed by the commission. The five boroughs are divided into 10 zones, and in most cases no tolls are levied between any two adjacent zones. The scheme shows some of the general features of its prototype in the Boston Metropolitan District (see "Engineering News," Oct. 20, 1910). A special investigating committee of the Legislature has already expressed its disapproval of the plan, in part because it does not make concessions enough to the small customers and there is a 10c. toll out of the more remote parts of outlying boroughs.

PERSONALS

Mr. Charles S. Fletcher has been appointed Manager of the Sack Bureau of the Universal Portland Cement Co., Chicago, Ill.

Mr. Gordon Wilson has resigned as Assistant Secretary of the Universal Portland Cement Co., Chicago, Ill., to enter the service of another concern.

Prof. Andrew C. Lawson has been appointed Dean of the School of Mining of the University of California, to succeed the late Prof. Samuel B. Christy.

Mr. H. M. Church, recently Division Engineer of the Baltimore & Ohio R.R. at Philadelphia, has been made Division Engineer of the Baltimore division, with headquarters at Baltimore. Mr. Church succeeds the late W. I. Trench.

Mr. Stephen T. Mather has been appointed by Secretary of the Interior Lane to take administrative charge of all of the national parks. Mr. Mather is engaged in the manufacture of chemicals in Chicago. In 1911 he was Chairman of the Chicago Section of the American Chemical Society.

Mr. A. G. Shaver, of Chicago, formerly Signal Engineer of the Rock Island Lines, has been appointed to act as Consulting Engineer of the Sanitary District of Chicago, in designing the signal and interlocking plants for railway bridges across the Sag Canal, now under construction.

Mr. George A. Ricker, M. Am. Soc. C. E., recently First Deputy Commissioner of Highways of the State of New York, has been appointed Consulting Engineer to the Highway Department by the new Commissioner of Highways, Edwin

A. Duffey. Former Commissioner John N. Carlisle is also serving in the Department in an advisory legal capacity.

Mr. J. L. Nichols, of the Pittsburgh Crucible Steel Co., has been appointed Assistant Superintendent and Assistant Metallurgist of the open-hearth plant at Midland, Penn. Mr. Nichols has had five years' experience in making different kinds of steels, the first three years of which he spent in the bessemer plant of the Lackawanna Steel Co., of Buffalo, N. Y.

Mr. Walter Alexander, who for the past five years has been District Master Mechanic, at Milwaukee, of the Chicago, Milwaukee & St. Paul Ry., has been appointed a member of the Railroad Commission of Wisconsin, to succeed Mr. David Harlowe. Mr. Alexander has served at various times on the faculties of the Universities of Wisconsin and Missouri and the Armour Institute of Technology.

Mr. Schuyler Hazard, M. Am. Soc. C. E., has been elected President of the Village of Albion, N. Y. Mr. Hazard graduated from the Massachusetts Institute of Technology in the Class of 1890, and for a number of years was engaged in railroad work. He was Resident Engineer for the contractors on the six-track work of the New York, New Haven & Hartford R.R., and later Resident Engineer for the contractors on the Pennsylvania Terminal, New York City. Since 1909 Mr. Hazard has been General Manager and Chief Engineer of the Orleans County Quarry Co., of Albion.

Mr. Andrew Alfred Woods, M. Am. Soc. C. E., recently Resident Engineer of the New Orleans & North Eastern R.R., has been made Superintendent and will continue to have his headquarters in New Orleans. Mr. Woods was born at New Orleans in 1876, and is a graduate of the School of Engineering of Tulane University. He began railway work as a rodman in the employ of the New Orleans & Western Ry. He was appointed Assistant Engineer of the Maintenance-of-Way Department of the New Orleans & North Eastern in 1899, and appointed Resident Engineer in July, 1913.

Mr. Clarence A. Bingham, Assoc. M. Am. Soc. C. E., recently Deputy City Engineer of Elizabeth, N. J., has been appointed Town Manager of Norwood, Mass. Mr. Bingham was one of 420 applicants for the position and one of 40 of the most promising who were personally examined by the Board of Selectmen. He was born at Elizabeth, N. J., and is 30 years old. He is a graduate of Rutgers College, New Jersey, and for several years was in the employ of T. Chalkley Hatton, M. Am. Soc. C. E., Consulting Engineer, of Wilmington, Del. Later Mr. Bingham was City Engineer and Commissioner of Public Works of Carlisle, Penn. He will assume his duties at Norwood, Apr. 1, and his salary will be $3000 per annum. He will be in charge of the departments of police, fire, streets, engineering, municipal water plant, municipal electric plant, building inspection, and repair of school and library buildings, besides the purchasing of supplies for all departments. He will not be handicapped by tenure of office laws, as the civil service regulations were abrogated by the new charter passed by the Massachusetts Legislature for Norwood. The Town Manager can appoint, discharge and fix salaries and wages of all employees.

OBITUARY

F. Felkel, President of F. Felkel & Sons, Architects and Engineers, of Pittsburgh, Penn., died at his home on Feb. 25 from penumonia.

W. W. Borst, first superintendent of the Denver & Rio Grande R.R., died Feb. 23 at Denver, Colo. Mr. Borst was previously associated with the Santa Fé Ry., with headquarters at La Junta. Later he became Assistant Superintendent of the Denver & Rio Grande and was stationed at Pueblo, Colo., for many years.

Joseph Mohr, President of John Mohr & Sons, boiler manufacturers of Chicago, died Mar. 1. Mr. Mohr was born in Chicago in 1855. In 1870 he was an apprentice to the Excelsior Iron Works, and remained with that firm until 1882, when he and his father started business for themselves. He became General Manager and Treasurer, and on his father's death, in 1903, became President of the firm.

John W. Addis, formerly Superintendent of Motive Power of the Texas & Pacific Ry., died at Marshall, Tex., Feb. 25. Mr. Addis was born at East Liberty, Penn., in 1851. He learned the machinist's trade and received his first employment in the shops of the International & Great Northern Ry., at Palestine, Tex. Mr. Addis retired in 1911, after over 20 years of service with the Texas & Pacific Ry.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 16-18. Annual meeting at Chicago, Ill. Secy., E. H. Fritch, 900 So. Michigan Ave., Chicago, Ill.

LAKE MICHIGAN WATER COMMISSION.
Mar. 19. Meeeting at Milwaukee, Wis. Secy., Edward Bartow, Director, Illinois Water Survey, Urbana, Ill.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Mar. 6. Meeting in Pittsburgh, Penn. Secy., W. T. Snyder.

AMERICAN CHEMICAL SOCIETY.
Mar. 31-Apr. 3. Meeting in New Orleans. Secy., Charles L. Parsons, Box 505, Washington, D. C.

American Society of Civil Engineers—The vote on the constitutional amendment to redistrict the society for representation in the Board of Direction was announced at the regular meeting Mar. 3. The votes in favor of the amendment were 1066 against 83 opposing votes. The amendment was accordingly adopted, although only about one-third of the corporate members voted.

Engineering Society of Wisconsin—The seventh annual meeting was held in the engineering building of the University of Wisconsin, at Madison, Wis., on Feb. 22-23. The officers elected for 1915 are as follows: President, C. U. Boley, City Engineer, Sheboygan; Vice-President, J. S. McCullough, City Engineer, Fond du Lac; Secretary, Leonard S. Smith, Engineering Department, University of Wisconsin, Madison, Wis.

American Institute of Electrical Engineers—A joint meeting of the American Institute of Electrical Engineers and the New York section of the American Electrochemical Society will be held Mar. 12, in the Engineering Societies' Building. The following papers will be presented: "Fixation of Atmospheric Nitrogen," by Leland L. Summers, and the "Cyanamid Process," by Frank B. Washburn. The session will be followed by a smoker.

National Drainage Congress—Owing largely to the conditions in Europe causing the United States Congress to set aside for the present session all reclamation measures, no definite date has been determined upon for the next meeting of the National Drainage Congress. E. J. Watson, President of the Congress, states that he expects to call a meeting of the Executive Committee very shortly, for the purpose of deciding upon a date. For further information address E. J. Watson, Dept. of Agriculture, Commerce and Industry, Columbia, S. C.

Appliances and Materials

Combined Auto Truck, Bitumen Heater and Distributor

The accompanying illustration shows a new type of distributor for either hot or cold bituminous road binders, in which the tank and distributing apparatus may be easily removed, leaving a motor-truck chassis which can be used for other purposes.

The bitumen is heated by kerosene-oil burners so arranged as to convey heated gases through tubes within the tank. The tank is not under pressure, but the pressure at the nozzles is obtained by a special rotary pump at the base of the tank. The nozzles and distributor pipes are designed to spray an 8-ft. strip of roadway. All valves and

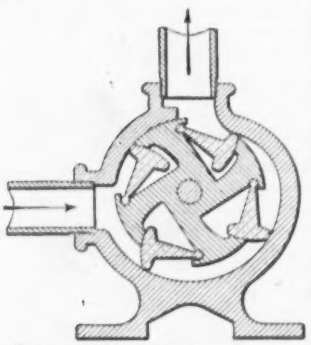
AUTO TRUCK WITH DETACHABLE TANK AND DISTRIBUTOR

controlling levers are manipulated by an operator on the rear of the tank. The distributor pipes and spraying apparatus are provided with a specially designed lateral control to prevent overlapping of the oiled strips. The spray pipes are provided with a sheet-metal shield to prevent the disturbance of the spray by the wind and to prevent dripping on cross-walks. Another attachment in place of the nozzles and spray pipes permits the tank and apparatus to be used as a pressure street flusher. The tank and distributing machinery are mounted on a separate subframe and it is necessary only to remove ten bolts connecting this subframe to the truck chassis to detach the whole apparatus from the truck. This heater and distributor is patented and made by the Kinney Manufacturing Co., Boston, Mass.

* * *

Rotary Pump with Automatic Adjustment for Wear

A rotary pump in which the revolving parts automatically take up added clearance due to wear is shown in the accompanying cut. The pump chamber is elliptical, and the runner has four arms, to each of which is pivoted a bucket. These buckets hang free and are held against the wall of the chamber by centrifugal force, no springs being employed. With any wear of the contact surfaces of the chamber and buckets, the buckets simply swing a little farther out so as to maintain the contact.



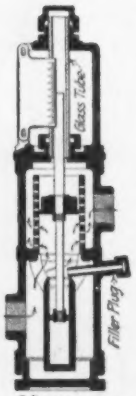
ROTARY PUMP WITH AUTOMATIC ADJUSTMENT

This pump is in use for handling liquids of various kinds (free from grit), including gasoline, oil and such heavy or viscid materials as tar and asphalt. It is built by the Blackmer Rotary Pump Co., Petoskey, Mich. Power-driven units have a motor or engine on the bed-plate to form a complete unit, or a pulley on the pump shaft. A small hand-operated pump also is made for taking liquids from barrels and tanks.

* * *

Flow Meter for Compressed Air

An interesting line of flow meters for compressed air supplied to tools of various sizes has been developed by the New Jersey Meter Co., Plainfield, N. J., under the trade names, "Toolometer" and "Drillometer." The principle on which the devices operate is that the volume of compressed air flowing with small constant loss of head through a number of orifices of the same shape and size is directly proportional to the number of orifices exposed. The design is shown in the accompanying illustration. The moving element consists of a weighted piston in the orifice cylinder, carrying a small piston below in an oil dashpot, and an indicating rod extending above in a glass tube alongside a scale plate. The air supply enters the lower chamber surrounding the dashpot cylinder, passes through ports into the interior of the orifice chamber, which is drilled with a large number of small uniformly spaced and accurately reamed holes. To pass the outlet chamber the air lifts the piston and exposes a greater or less number of the orifices. A small difference of pressure is established between the inlet and outlet chambers; this is only a few ounces per square inch and is fixed by the weight of the moving element. The latter rises until the weight is balanced by the orifice head at a position corresponding to the volume of air flowing, to the number of holes exposed and to the height of the pointer rod on the scale. The latter is calibrated by comparison with a standardized instrument.

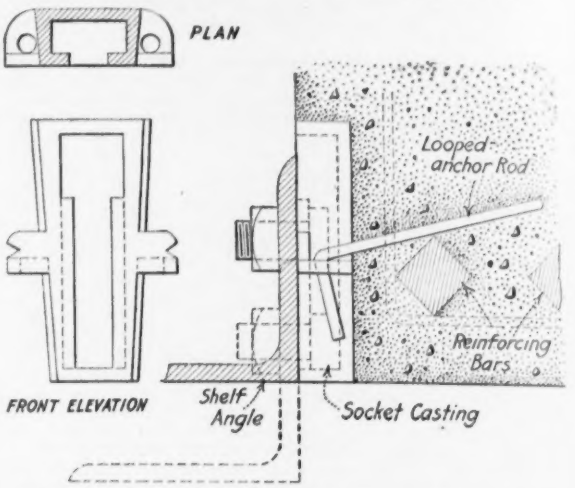


MULTIPLE-ORIFICE AIR METER

The "Toolometer" is recommended by the makers for metering the supply to riveting hammers, hand drills and other small tools rated to require not over 60 cu.ft. per min. when new. The "Drillometer" is intended to be used with mounted rock drills, coal punchers, sand blasts, air lifts, pumps, pile hammers, hoists, etc., where the consumption is not over 300 ft. per min. For larger supplies two or more meters, of course, can be used in parallel. The smaller meter sells for $50 and the larger for $75.

Insert for Attaching Shelf-Angles to Concrete Walls

In veneering concrete walls with brick, it is general practice to support the facing on horizontal shelf-angles. The accompanying sketch shows an insert attachment for securing these shelf-angles on the wall, its special feature being that



INSERT FOR ATTACHING SHELF ANGLES TO CONCRETE WALLS

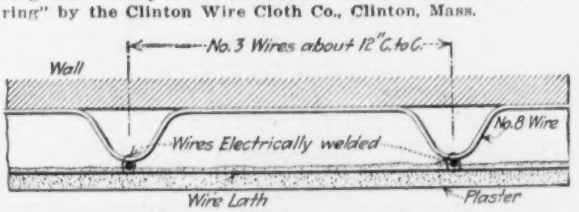
it avoids interference with the reinforcement bars in the concrete at lintels, etc. It is the invention of Hugues Brussel and is being introduced by the Reinforced-Concrete Co., 1417 Wright Bldg., St. Louis, Mo.

The device consists of a socket casting about 6x2 in., having a T-section socket to receive the bolt heads, and it is secured by a short U-anchor which has its ends hooked into the lugs of the casting and can be adjusted so as not to interfere with the reinforcing rods in the concrete. The castings and anchors are set in the forms and are spaced usually 30 in. apart. The bolt holes in the angles are slotted horizontally so as to allow for slight variations in the bolt spacing.

* * *

A Wire-Cloth Wall Furring

The wall furring shown herewith consists of electrically welded wire cloth, of 12x12-in. mesh, with the small (No. 8) wires crimped at the intersection of the large (No. 3) wires so as to provide that the latter, on which the wire lath and plaster are placed, will be offset sufficiently to form an air space between the wall and the plaster face. The No. 8 wires are fastened to the wall by galvanized wire ties. This furring has been put on the market as "Clin-Trus Wall Furring" by the Clinton Wire Cloth Co., Clinton, Mass.



HORIZONTAL SECTION THROUGH "CLIN-TRUSS WALL FURRING"

High-Head Single-Stage Centrifugal Pump

A very simple design of high-pressure single-stage centrifugal pump has been developed by the Holland Machine Co., 410 East 32d St., New York City. The important features are a single-suction inclosed overhung impeller of equal width in suction and discharge openings, a volute casing of circular cross-section with cast-on feet supporting the pump on its baseplate, two heavy bronze water-lubricated bearings carried internally by the casing, hydraulic and mechanical thrust balance, etc. A 3-in. pump has shown on test at 1800 r.p.m. a delivery of 205 gal. per min. against a head of 100 ft., at which point a mechanical efficiency of 50% is developed. As the delivery was throttled the head rose to 180 ft. for this speed. The line includes pumps with from 1½- to 5-in. suction and discharge; a similar design has been worked out for two-stage machines.